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ERRATA

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Page 84, line 6 after "longa" add a comma.
Page 84, line 14 after "10" add a comma
Page 84, line 15 after "longa" add "debilia, "
Page 84, line 23 for "gamosephali" read "gamosepali "
Page 84, line 45 for "amnibus" read "omnibus "
Page 85, line 8 for "hand" read "haud "
Page 85, line 24 after "Lundell" add "no 1555 "
Page 85, line 31 delete commas after "acicula" and "longas "
Page 85, line 41 add comma after "9 "
Page 85, line 52 for "retrosis" read "retrorsis "
Page 86, line 5 delete comma after "integra "
Page 86, line 10: for "ablongo" read "oblongo "
Page 86, line 26 for "disolutam" read "dissolutam "
Page 86, line 28 for "fur-furaceae" read "furfuraceae "
Page 86, line 31 add period after "obtectae "
Page 86, line 34 for "proper" read "prope "
Page 86, line 36 for "ven" read "vena" and after "prominenti" add a comma
Page 86, line 37 for "longitudinalibusa" read "longitudinalibus "
Page 87, line 7 for "ferior" read "subinferior "
Page 87, line 25 for "derosum" read deorsum "
Page 87, line 26 after "longa" add a period
Page 91, line 46 for "Hurd Karrer" read "Hurd-Karrer "
Page 122, line 6 for "N Froderstrom" read "H Froderstrom "
Page 123, line 6 for "juparnse" read "juparense "
Page 503, line 9 for "Ponona" read "Ponana "
Page 509, line 1 for "Foral" read "Forel "

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PSYCHOLOGY.—*The frontier of the mind.*[1] WILLIAM A. WHITE, St. Elizabeth's Hospital, Washington, D. C.

I have been asked to present to the Academy a communication upon the general subject of the ability of man, from the point of view of his mental make-up, to go on adjusting himself to the ever and rapidly increasing complexities of the world he lives in. I take it that the present state of confusion throughout the world has raised the issue in the minds of many that perhaps man is so constituted that there are limits to his capacity for accomplishment along those lines and that perhaps there are indications that those limits have been reached. I shall be very glad to deal with this subject, but in order to do so I feel that it will be essential to attempt to orient you somewhat to the new ways of thinking which have affected interpretations of psychological events in recent years, so that you will know the basic features of this new psychology with which you will be enabled to reach some conclusion with reference to the issues stated.

In the first place, I must tell you to begin with that the psychology that many of us were taught in our college days has in large part, and almost entirely in certain very fundamental ways, been superseded. The psychology of the nineteenth century has rapidly become of interest only from an historical standpoint, and the developments as they are taking place now require an entirely different point of view regarding all things psychological.

In the last century the study of the mind was still more or less entangled with its associations with ethics, on the one side, and philosophy on the other; and it is only in the present century that it can be said to have become a really scientific discipline and a branch, in my estimation, of biology which deals with certain aspects of living beings. In changing, however, in this radical way and becoming scientific it has naturally had to break with many traditions, and these traditions still tend to find expression in the language we use and to contaminate our thinking.

[1] This paper is the manuscript of a lecture delivered at a meeting of the ACADEMY, November 21, 1934. Received November 28, 1934.

For example, one of the problems that confronted the psychologists of yesterday was the so-called *body-mind problem*. What was the relation between body and mind? The mere asking of the question involved the assumption that they were separate one from the other, and, further, that the mind in some way was added to the body in the process of evolution at some particular time—it took up its habitation in some special group of living beings and maintained there an existence which was separate from that of the body and yet in a mysterious way intimately related to it. Modern psychology is no longer vexed with this problem, because the way in which we think of man now is such that a query of this sort has ceased to have meaning and therefore the question is no longer asked.

You will gather, therefore, from what I have said that what has happened in the realm of psychology is that different ways of thinking have come to pass, which automatically have disposed of many of the problems of the last century but which quite characteristically have raised many new ones in their stead.

I think, therefore, that I perhaps can serve you best if I give in brief outline some of the ways in which we now look at matters psychological, and you will note how they differ from the psychology of the nineteenth century, which not only considered the mind as a separate entity but dealt with its several faculties—intellect, emotion, and will—as if each of them had an existence of its own and controlled a certain group of phenomena, somewhat after alleged bureaucratic methods.

Present-day psychology differs in its way of thinking about the human organism, very much as other disciplines have come to differ in the past few years. It looks upon the organism as a whole, and that aspect of it to which we give the name "mind" we think of as only one point of view, or one facet of a many-faceted surface to which we direct our attention. We do not conceive that mental phenomena were added somewhere in the story of evolution, but because what we call mental are only a part of or only constitute one aspect of the phenomena of living beings, this aspect was present from the first but naturally in a manifestation as simplistic as the corresponding bodily structure, so that what we now call *mind* and *body* instead of being separate and distinct are merely different aspects of the living organism which have developed together throughout the story of organic evolution. For purposes of convenience, however, we may speak of the mind as such in the sense of the organisms' reactions at the psychological level and describe its evolution both in the individ-

ual and in the race, and, also, it can be studied from its earliest manifestations in the lower animals. We deal with it in this way precisely as we deal with a living organism: a dynamic, expanding group of processes, becoming more complicated along the way as the problems it has to meet require changes in this direction.

Now this study leads us to the conclusion that what we ordinarily think of as mind, namely, what I prefer to call *conscious awareness*, or perhaps, better, *self-conscious awareness*, is the last thing to occur in a long series of developments, and so it is not difficult to understand that if all the time we have been mistaking this for mind in its totality we have necessarily reached many false conclusions regarding its ways of functioning, if for no other reason than because we have been dealing with only a small portion of the total phenomena. I perhaps can illustrate this by a figure of speech. We are all familiar with the modern searchlight. I have watched it many times from the deck of a river steamer at night as it played along the banks and illuminated first one and then another bit of scenery. Now the area of conscious awareness is like this small area illuminated by the searchlight. The content of the area stands out with clear definiteness. It is perceived in the form of concrete objects, and the functions in this area are equally clear-cut and definite. They constitute reasoning, judgment, discrimination, perception. But you will note that this bright spot is only a minute part of the total situation and that outside it there is a region of twilight or darkness in which we see nothing clearly – perhaps vague outlines, little more. This is the region where all clear-cut distinctions and definitions of outline are lost. This region instead of being the region where reason functions and where clear-cut definitions and differentiations prevail, is the region of the emotions, or, speaking more generally, the feelings. It is in this zone that our instincts manifest themselves, our intuitions have play, and instead of being governed by intellectual processes it is the region in which instinctive forces, natural desires, the avoidance of pain, the seeking of pleasure, prevail; in short, the region where the wish holds sway, unimpeded by the necessity for conforming to the limitations imposed by a world of harsh realities and natural laws. Reasoning gives way to phantasies, and things happen because we want them to. The *omnipotence of thought*, as we call it, rules here supreme. Things are true because they are thought to be true, and for no other reason. It is the land of dreams and their realization. It is the region above all in which we live as the other region is that in which we think.

Now this dark surrounding territory of indefinite extent is just as

much a part and parcel of the mind as the small, bright, illuminated spot. In fact it is more necessary because more fundamental; and what we are particularly interested in now is, How valid may be the reasoning from things as they are seen in the illuminated area of the searchlight, with all these forces in the background left out of consideration? I seem to have answered my question in the asking. Obviously if we wish to arrive at true interpretations, the background against which the brightly illuminated objects are seen can not be neglected.

Now for a moment to indicate how in the course of evolution this central nucleus of brilliant illumination has gradually become differentiated from this background of instincts and feeling. There is in all living creatures some impulse -define it as we will, we do not understand it—which ensures what we are pleased to call progress, development, evolution. In the course of that evolution a number of things have happened. Those that interest us at the moment are these. In the lower forms of life reproduction took place at a tremendous rate and these organisms could afford, so to speak, to make great numbers of mistakes in dealing with the forces of the environment because myriads of them could be destroyed and the species still persist. But as life attained to a more and more complicated structure in response to its adjustment to the various forces which it had to meet, these adjustments became increasingly accurate and at the same time reproduction fell off accordingly, so that finally our capacity for adjustment has reached such a point that reproduction has only to develop single individuals where before it developed millions. This increased accuracy of adjustment is in itself almost the same thing as conscious awareness, because it involves not only clearer and more clean-cut perceptions of the situation to which it is necessary to adjust but it also involves the necessity of delaying immediate response, bringing into the picture the results of past experience and so further illuminating the possibilities of choice and then finally reaching a conclusion which can be carried out in action sometimes extending over many years of time. All this requires an intensity of fixation upon the specific problem of adjustment which is in itself an outstanding characteristic of that very clarity of vision which is part and parcel of conscious awareness.

Now I think if I have succeeded in making myself clear, but I fear that perhaps I have not—that we have a picture of what we call mind as a developing organism which tends to focus in a point of clear consciousness but which has back of that clear consciousness all the

organized tendencies of the past millions of years, plus those of the individual himself, as motivating factors that modify and control what takes place at that particular locus—a situation already, you see, that involves a complexity which if we try to visualize it is to all intents and purposes infinite.

Such a concept naturally leads to still further and very interesting conclusions. I think it was Bergson who said that he did not know how "life insinuated itself into dead matter." Perhaps we need not undertake to answer that question here, but it would seem obvious that the laws of the cosmos in the course of the origin and evolution of living forms have impressed themselves upon life in such wise that these living forms have incorporated within themselves these very laws, only they are expressed under material conditions modified by the existence of what we call life. In other words, tiny man who creeps about on this planet is not the lord of creation, in spite of the fact that he still thinks he is and acts as if he were. The world within is the impress of the cosmos upon him, and if, as some of the psychologists have expressed it, man projects laws, order, meanings upon the world, these projections are in turn but reflections of the world's impress upon him. You will see, therefore, that I have drawn here the picture of man and the rest of the universe as acting and reacting upon each other in a process of adjustment which continues to proceed along the lines which we are accustomed to in our understanding of development and evolution.

One of the outstanding facts in the course of the recent history of man was the realization by the astronomers of individual differences as between different observers of celestial events, with the result that the so-called *personal equation* was evolved as a corrective to these differences and as an assistance to more accurate readings. It began to be appreciated then that man's observation of the world was by no means infallible. Not only were his sense organs defective, but the time of transition along his nervous pathways was not always the same, in other words, he was a very defective instrument with which to observe and record the outside world. It was not a very great step from this realization to the further one already implied in my account, that the world only exists for him as this imperfect instrument perceives it and that therefore in a very real sense every individual lives in a world of his own, and that that world is a little bit different from anyone else's.

It has been indicated that the chance of a particular germ plasm combination taking place is one in five million billions. In other words,

each of us represented that one chance when we became ourselves. This, from a purely physical point of view, gives us some idea, therefore of what the possibilities of variation are, expressed in terms of chromosomes and genes. Now, having developed this unique personality different from any other that ever existed or ever will exist, we are confronted by a world which is in constant change and which bombards us with a series of sensory impressions, probably by the millions, each hour of our lives, and these impressions are received in a machine which has been built up through millions of years of evolution, as it were, for the purpose of handling this material.

The human organism is a receiver, transformer and transmitter of energy, energy that comes from all these myriad sources and is received into an organism quite as complicated as the world from which it comes. A single portion of the brain, the cerebral cortex, a thin layer of 2 to 4 mm. in thickness covering the cerebral hemispheres, contains cells (incidentally the most complicated cell structures in the body) somewhere in the neighborhood of nine to ten billions in number. And so if you will think of all these things you will have some idea of what the possibilities are, expressible in matter and energy, with which the organism has to contend. Now these figures are so stupendous and at the same time so vague that they can not have a very great deal of meaning, except that obviously there must be in this organism a plastic capacity which has enabled it to proceed thus far on its path; and I may add that as we go from points of definite structure in the organism and proceed in the direction of the last additions which have been made in the evolutionary process, namely, to the possibilities of psychological function, we are moving in the direction from the least modifiable toward the more modifiable, and that therefore we may expect to find, as we in fact do, that man through the years has changed more in his thinking functions than he has either in the functions of his organs or in their structures. To all intents and purposes so far as we are concerned man's anatomy and physiology remain fixed and unchanging facts, whereas experience teaches us, to the contrary, that psychologically he continues modifiable more or less throughout his life, but of course his modifiability is greatest in the early years. From such facts of observation as are vailable to us when dealing with human beings, we know that the possibilities of modification in many instances are very considerable; and I may say merely as a result of the precipitates of experience which control my thinking, without perhaps the ability to bring concrete evidence to bear upon the subject, that there is no indication

so far as I know of any limitation to this modifiable and adjustable capacity of the human being. There is, on the contrary, all along the way historical evidence that he has always been apprehensive that his adjustment would break down, that he has always seen society as an overwhelmingly complicated affair and felt that the time was coming when he could no longer keep up with the procession. This is his natural response to the pressure which is put upon him to go forward on the path of progress. As he gets older this pressure is felt more and more and develops contemporaneously with lessening powers of adjustment; and then Nature comes forward with her cure for this situation, and her cure is death, and the new generation takes up the problems where the old generation left them. For example, we have today all these new and marvelous results in the realm of physics and mechanics and astronomy which have largely come about as a result of Professor Einstein's contributions. There are very few people in the world who are capable of understanding these results, only a handful of people in fact; but if they are true—and I take it they are—I suspect that future generations will understand them as easily as we do that the earth is round. And yet there must have been a time when the fact of the roundness of the earth was quite as difficult of comprehension to the masses of the people as the Theory of Relativity is today; but young, plastic, adjustable minds, unhampered by the prejudices of yesterday, will grasp these new concepts quickly, as they have in the past.

There has never been any question about man's adjustment to life under the seas or in the clouds, or to temperatures at the poles or the tropics. But his most difficult task is to adjust to his fellow men; and in the present century the emphasis that psychology, and particularly psychiatry, has received is an earnest desire for the probable development of his understanding of himself, which will in time be comparable to his understanding of the rest of the world. At the present time, of course, this is not so. It is generally conceded that his knowledge of himself is far below his knowledge of the world about him. When these two fields can be comprehended with something like equal understanding there will be a new capacity for man's adjustment to his fellows far in excess of anything that we have ever imagined.

So much for fundamental principles. It may interest you at this point to consider with me for a few minutes what light, mental disease in its various forms sheds upon the problem under discussion. In the first place, let us look at the development of our thinking from the

standpoint of the way in which medicine has responded. Nineteenth century medicine was outstandingly characterized by the development of the various medical specialties. The accumulation of knowledge about the human organism, the way it functioned and its various diseases, progresses so rapidly that it became a rather hopeless task for individual physicians to attempt to master the whole field, and so they solved their difficulty in this respect by confining their attention to disorders of certain organs or groups of organs. You are familiar with this state of affairs. But unfortunately this development contained an inherent defect. Organs could not be adequately considered apart from the rest of the organism and when the concept organism-as-a-whole began to develop this fact became outstandingly clear. Perhaps psychiatry has done more to develop this aspect of the situation than any other department of medicine because psychiatry looks upon the organism as a group of organs associated together in a common purpose, and that purpose is none other than to effect a more adequate adaptation to the environment and to so modify that environment by acting upon it as to bend it to the purposes of the organism. In other words, the purpose of the organism-as-a-whole can only be expressed in psychological terms. The functions of all the organs focus in this psychological objective, and therefore psychiatry at once became interested in the whole individual.

This point of view receives a rather startling confirmation in the statistics of mental disease as we see them represented in our public institutions. To begin with, for the most part our mentally ill patients are not physically sick in the ordinary sense of that term. If they have deviations from the normal in their several functions these deviations are so comparatively small that as yet we either are not able to define them or to interpret them. On the other hand, if we take the great mass of mentally ill we do find the startling fact that despite all our efforts to the contrary they die at a rate something like six times greater than the general population. You see this fact confirms what I have said, and in addition it also confirms what I have implied of the organism; namely, that it is an energy system, and when the flow of energy is impeded and the necessary adjustments both within and without the organism are therefore impossible of effecting, the organism-as-a-whole functions at a lowered efficiency and the span of life is correspondingly shortened. Now let us see how this works in a particular situation.

Let us revert to the figure of speech I used earlier of the searchlight which brightly illumines only a small spot in an otherwise uniformly

dark medium. You recall that I spoke in general of the distinction between these two areas, and that intelligence dominated the former and wishes the latter; and you will recall, also, that the wishes that are formulated in this dark territory express the fundamental instincts of life, and the mental processes that occur in the illuminated space represent those more accurate adjustments to the material facts and the natural laws of the environment, physical and personal, in which the individual lives. It is easy to see from this statement how tendencies in these two areas not only may be but must necessarily be frequently opposed one to the other. Let me imagine an example. An individual is so situated that his only source of water is a stream polluted with the germs of a deadly disease. If he drinks of the stream he will surely die of the disease. He can only preserve his life by not drinking, but, paradoxically, if he does not drink he will die of thirst. The agony of thirst increases as the hours pass. Temptation to drink from the stream becomes intolerable. He resists it as long as possible because he knows that drinking means death. The desire to slake his thirst, to supply his organism with the necessary fluid, originates in the dark region where the instincts and the wishes govern. The fear of drinking, the apprehension of the result if he does—all these things come from the clearly visioned situation as he actually sees it in the world in which he has to live and to which he has to attempt to adapt himself. The desire that emanates from this larger region, which, in harmony with present usage we will call the unconscious, is in conflict with the knowledge that the individual has and the fear resulting from that knowledge of death if he yields. This, of course, is an extreme example, but it shows how a life and death struggle may take place between the opposing demands of these two regions of the mind. In all our nervous and mental diseases we have, among other things, a similar situation with which to deal. We have this so-called conflict between these two great regions at the basis of these disturbances, and one of the outstanding results of this conflict, which I am sure you can comprehend easily from the example which I have just given, is that the energies of the individual are used up in a futile battle and are not, therefore, available for those possible adjustments which would make for greater efficiency of living. And the problem of therapeutics at this psychological level with which we as psychiatrists are most concerned is the very problem of helping the patient to effect some kind of permanent solution, or, if not a solution at least a compromise, with these contending forces so that the energy engaged in the conflict may be released for more effective use.

Just a few words at this point by way of hints, so that you will have some idea how this works out actually. The cruder ways in which this conflict not infrequently manifests itself is in alternating swings between the attempts to satisfy each of the two contenders in this intrapsychic conflict. And so we see that the individual lives for a certain time in accordance with his ideals and gets along very well, but during this period the tendencies from the other side are constantly nagging him. They are increasing in strength just exactly in the same way that in the example I have given you the man's thirst increased, until they finally reach a point where they have accumulated so much force by this slow process of impounding that they can no longer be restrained and they break forth, sometimes expressing themselves as the epileptic convulsion, and in this breaking forth they not infrequently express themselves in aggressive and destructive conduct. Quite characteristically this destructive conduct is addressed against the world at large, and in the epileptic furor the patient spreads ruin and destruction all about him, and woe to anyone who attempts to interfere with him. It is as though he were wreaking his vengeance upon a world which had created within him by various stimuli certain desires which he was incapable of fulfilling. Then, equally unfortunately, these same aggressive and destructive instincts are turned upon himself and he would destroy those very parts of his body through which these stimuli to which he can not respond transmitted themselves. And so we find patients mutilating themselves in the most hideous manner, digging out their eyes, biting off their tongues, castrating themselves, and, finally, sometimes by the most painful methods, committing that final act, complete and irrevocable, of self-destruction. These are just some of the more terrible things that we see when serious disharmony affects the organism in the ways which I have described and which result in destroying its efficiency and even in destroying its life.

Perhaps with the background thus far developed I can indicate another point of view very briefly, which you may find interesting but which I must warn you, to begin with, is largely speculative. You will see as I have developed my thesis that I have pictured an organism all the several parts of which are constructed for a common purpose, and that purpose only finds its full expression as it heads up in the tendencies which come to expression, in the functions of the mind. In addition to that, the implication seems fairly evident that if I have correctly indicated the forces that are involved in the functioning and the purposes of the organism, that this organism is grow-

ing, expanding, developing, evolving at this head end, not unlike, by analogy, but of course in a very much simpler state of affairs, the way that the root of a plant develops through the intermediation of the root tip. The further implication of this point of view is that the experience to which the living being is subjected by this constant necessity for adjusting to the environment, and which experience has been in process of evolution through living organisms now for millions of years, is gradually, just as we see it in the growth of the individual organism, laid down in what amounts to permanent structural details. In other words, when a given necessity becomes of survival value, the function that satisfies that necessity is precipitated, as it were, in the form of organic structure; and thus we have at the heart of each organism certain definite, well-defined structures that vary only within narrow limits as between individuals and which represent the answers, so to speak, which the organism has developed in its response to the queries presented to it by the environment through the ages.

In order that this process of adaptation may continue, not only from generation to generation but from youth to old age, there has to be a certain retained plasticity on the part of the organism, a certain possibility of change; and this possibility, as I have indicated, is greatest when we come to the more recently acquired adaptations, as they are expressed in the functions of the mind. Without laboring this point further, let me draw the conclusion, which might be supported by a great deal of concrete evidence, that this modifiable aspect of the organism represents a strategic point of attack which offers possibility of modification; and, therefore, when the organism is functioning inadequately, it is not beyond the possibilities from our present knowledge to look forward to a time when the field of psychotherapy will be much larger than it is now, when illnesses will be attacked from this angle much more frequently than they are at the present time, and that much of the therapy which is now addressed directly to the soma, the more definitely fixed portions of the organism, will go out of use, and, correspondingly, therapy addressed to the psyche, the more modifiable forms, will come into practice.

I have given you in this brief paper. first, a discussion of the fundamentals from which we must proceed if we are to answer the question as to how far we may expect man to go in the future; secondly, some illustrations of how the forces at his disposal may be distorted and impaired in their utilization; and, thirdly, a suggested view of the future. From all of these three points of view I gather a definite feel-

ing, and that is that the greatest asset of man today is his mind, that the greatest unexplored and largely unknown territory in all the world so far as we know is this same region, so that I feel today that we are entering upon a new chapter in the history of human development, that we are pressing forward into the unknown along a new frontier of great and apparently inexhaustible riches, and that frontier is the frontier of the mind.

Now just a few words with regard to this frontier territory that we are only beginning to enter upon. What is it like, and what may we expect to find in it? I may reply very generally by saying that it is very much like all frontiers. The explorer who has pushed his way into a new country must always be prepared to meet with hardships and dangers, and the reward of the frontiersman is in proportion to his ability to overcome these obstacles. Extremes of temperature, floods and drouths, great forests and wild animals, to say nothing of tribes of savage men who look upon him as an enemy, represent the types of difficulties he has to meet; but if he succeeds he is rewarded by the fertility of an untilled land and the richness of unexploited deposits of precious metals and the like. It is similar, so far as we know, to this unexplored region of the mind. As soon as we begin to search earnestly, systematically, and assiduously in this territory we find all the terrors and all the obstacles that belong to unsettled and uncivilized regions; and here, as elsewhere, it takes courage to press forward, for, quite contrary to the assumptions which are tacitly made regarding the nature of man, the things that are found are often too terrible to be acknowledged, much less studied and understood. Man is neither wholly angel nor wholly devil, but both aspects are intertwined in his character; and just as his capacity for good is very great, so is his capacity for evil. Man prefers to think of himself without these handicapping qualities of which he is not at all proud, and so he lives in a hypocritical atmosphere of self-adulation much of the time. A little thought of the story of man as he has come to be what he is, would make it perfectly understandable why these characteristics still cling to him. It is only a very little while ago, comparatively, in the story of his life on earth, that he himself was a savage, and this savage state existed for hundreds of thousands of years, and before that he was an animal, and that stage lasted much longer. The characteristics of these stages were essentially animalistic, and if he has arrived at what we are pleased to call civilization it is only because he has been able to survive, and if he has been able to survive it is only because through these ages he has been willing to kill. He

has reached his present estate literally by leaving a trail of blood behind him, and naturally we must expect to find at least the remnants of those destructive and aggressive qualities which I have already intimated exist and which I now say characterize him in large part.

The frontiersman, if he wishes to conquer Nature, must have the courage of his convictions. He must be willing to face the dangers that are in his path. It is precisely the same way with ourselves. We can not alter ourselves, or reach higher stages of civilization by ignoring our own characteristics. We must appreciate and understand them if we are to deal with them intelligently, overcome them, capture the energies which now are dissipated in their destructive activities and conserve them for socially useful and acceptable ends. And this method of procedure requires work, hard work, continuous work, in order that it may yield valuable results. The frontiersman lived a hard life, but if he succeeded he reaped untold material riches as well as health and happiness; for it is written: "In the sweat of thy face shalt thou eat bread." The difference here from the popular conception is that the real dangers that confront him come from within. The thing in all the world that man is most afraid of is himself, the forces that are in him and which if let loose would express themselves in destruction, ultimately destruction of himself. This you will be able to realize when I suggest that the three great crimes which man has been guilty of through the ages, the crimes which are not made by statute but which are, as the lawyers say, "evil in themselves"—murder, incest and cannibalism, are still with us. I do not need to convince you that murder is by no means a lost art. We only have to think of the last war and read the newspapers. Incest, of course, few of you, I am sure, have had any contact with; but those of us who deal with the illnesses of people, and their defects, know that it is far from rare, while cannibalism still exists in remote places and occasionally crops out at our own level of culture under peculiar conditions of stress. It would perhaps be strange if this were not so, for, after all, the patterns in which man has expressed his fear, his hate and his aggressive and destructive tendencies are probably pretty well a part of our fundamental make-up which we have carried through the centuries and which is still with us even though buried deep in our natures. Therefore I am sure, you can understand with what good cause man should be afraid of himself, afraid lest these instinctive tendencies should be let loose and fall into their accustomed patterns of expression.

When we come to the content of our psychic life we find that for the most part we are quite oblivious of anything that is not within

the circle of clear conscious awareness, but those of us who are sufficiently honest and sufficiently brave, who really and truly examine our own thinking and feeling processes, are aware that on the fringe of this brightly illuminated area quite a good many things are happening which we ordinarily do not take account of. Perhaps one of the most significant symptoms and one of the most widely dispersed is anxiety, and this symptom of anxiety comes into the picture whenever our safety and security is in any sense jeopardized. It is the red light that warns us of danger, danger from within and danger of the particular character that I have mentioned, namely, that the instinctive forces will break through the barriers that civilization has erected and carry destruction with them. In fact, it would seem that the growth of civilization and the various institutions which have been erected as means by which mankind comes to a more effective handling of his environment are all of them, in a sense at least, the result of reactions calculated to protect the individual from anxiety, and that we progress along the path of evolution and development rather timorously, one might say, afraid all the time, threatened from forces both within and without, constantly strengthening our position and seeking always for safety, permanency and equilibrium, goals which can never be attained but which as a result of our continuous seeking bring to pass constantly improved methods of adjustment. Every success, every overcoming of an obstacle, every solution of a problem, makes possible new successes, new obstacles to be overcome and new problems which must be met. So that we have a never-ending process of which we are a part. We must always go forward. We are on the treadmill of life and we must advance or die. Anxiety is one of the symptoms which indicate this mechanism, so that we are beginning to see, at least vaguely, what it is that makes the machine work; of course, not really and fundamentally, perhaps, but at least we get the hint.

All these things that I have said to you have grown out of the suggestions which the newer developments in our field have thrown up with regard to some of the age-old questions which have confronted us. As I have already indicated, my feeling is that we are on the verge of an entirely new era in the development of our understanding of ourselves, and that the outstanding characteristic of this new era will be our ability to ask of the organism a certain type of questions which we are only beginning to be able to formulate. In other words, we have studied the details of the functioning of the organism now these many years. We are beginning to see back of

these details something which we appreciate is the totality of the organism itself, and we have accumulated enough knowledge of this totality by the investigation of these details so that we are beginning to be able to take the next step, which is to ask intelligent questions of this organism which will give some information about it.

I hope, if I have done nothing else, that I have convinced you that at least I think that this region of the frontier of the mind is a long, long way from having its possibilities exhausted, in fact that we are just entering upon a vast territory which will be many, many years in the frontier stage of development, and that the winning of this territory holds out the prospect that for the first time man will really have come to some understanding of himself based upon accepted principles of science.

PHYSICS.—*An apparatus for measuring the magnetic susceptibility of liquids and solids at high temperatures.*[1] R. B. SOSMAN and J. B. AUSTIN, Research Laboratory, United States Steel Corporation, Kearny, N. J.

The apparatus described in the present paper was developed by the senior author several years ago at the Geophysical Laboratory, Carnegie Institution of Washington, and results obtained with it have been published, but no description has yet been put into print. It has been found useful in determining the susceptibility of solids and liquids, both paramagnetic and diamagnetic, through a temperature range from room temperature to 1000°C, and it has the advantage of being quickly adaptable to substances having a wide range of properties. It is now in current use at the Research Laboratory, U. S. Steel Corporation, at Kearny, N. J.

METHOD

The method depends upon the familiar principle of weighing the force acting upon a known mass of the substance in the non-uniform magnetic field of a solenoid.[2] Any paramagnetic or diamagnetic substance is acted upon in a magnetic field by a force proportional to its magnetic susceptibility, to the field intensity, and to the field gradient. If the magnetic field possesses cylindrical symmetry, the resultant

[1] Received Oct. 16, 1934

[2] The method was first used for quantitative measurements of susceptibility by BOLTZMANN (Sitzungsber Akad Wiss Wien, Math -Nat Cl 80, II 687–714. 1879) and VON ETTINGSHAUSEN (Ann Phys u Chem 17: 272–305 1882) and has not been used since that time, possibly because of the complicated calculations necessary to obtain absolute values.

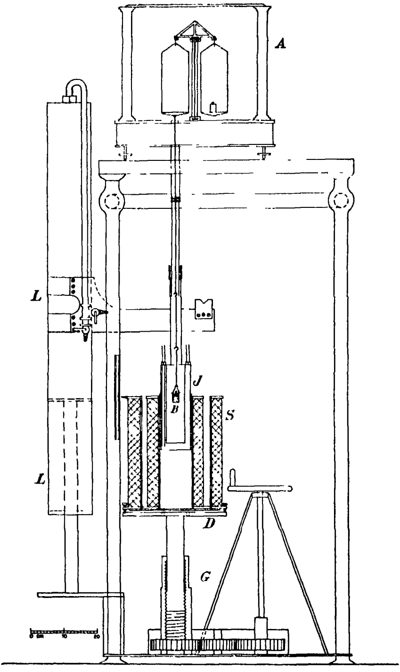

Fig. 1.—Front elevation, and partial cross-section, of apparatus for measurement of magnetic susceptibility. Arrangement for measurements near room temperature.

force is along the axis of a cylinder. Hence if the cylinder is set with its axis vertical, the force can be opposed to the force of gravity and weighed with the equal-arm balance, which is one of the most sensitive and precise of physical instruments.

With a good analytical balance, and with proper attention to outside disturbances, the force can be weighed to ± 0.005 milligram. The sample may be from 2 to 50 grams. With the field constants used in our apparatus, the corresponding variation in the mass-susceptibility is 0.1×10^{-6} to 0.004×10^{-6}. On paramagnetic (high-temperature) iron and on iron compounds such as ferrous sulfate this is equivalent to a precision of about 0.3 to 0.01 per cent. The corresponding absolute accuracy, which involves a knowledge of the field constants as well as the force, is estimated at 1.0 to 0.2 per cent. Many paramagnetic and diamagnetic substances, however, have such a small susceptibility (equal in some cases to zero) that a statement of percentage accuracy is misleading; the more informative statement is that the susceptibility is measurable within about 1.0×10^{-6} divided by the weight of the sample. The larger-sized samples can be used only for measurements near room temperature, since the diameter of the furnace tube is necessarily small and the object or container used for high-temperature measurements cannot be more than 14 mm in diameter.

With a ferromagnetic substance the force depends not only on the factors mentioned above but also on the size of the individual particles, the shape of the particles, their distance apart, the shape of the charge as a whole, and the previous magnetic history of the sample. Therefore, only somewhat crude comparative results are obtainable by this method with a ferromagnetic powder. The same is true to a greater or less degree of all the other methods applicable to such material.

APPARATUS

The apparatus used in making measurements at room temperature, as shown in Fig. 1, consists of an analytical balance from one pan of which is suspended a container located in the axis of the solenoids which produce the non-uniform field. For convenience in description the apparatus is divided into four sections: (1) Weighing system, (2) Suspension and container, (3) Solenoids and electric circuits, (4) Furnace and apparatus for control of temperature.

(1) *Weighing System.* The force acting on the specimen is weighed directly by an Ainsworth analytical balance (A) sensitive to 0.005

mg. This sensitivity is ample for all except the most feebly paramagnetic or diamagnetic substances, for which a microbalance would be preferable.

The pointer of the balance is made of a non-ferrous alloy and the knife edges are of agate, thus removing the necessity of correcting for the effect of induction in those parts of the balance that are sometimes made of steel. This construction is desirable since experience has shown that the effect of steel parts, even at a considerable distance, is not negligible. While the error caused by a steel knife edge is small and is easily corrected for, the error arising from a steel pointer may be fairly large. To prevent certain irregularities which were found to be due to the accumulation of an electric charge on the balance in cold dry weather, a small amount of carnotite ore is kept in a glass dish in the balance case.

The balance itself rests on an Alberene stone slab which is supported on a pipe frame, making part of a heavy table. The frame as well as all other parts of the apparatus is of brass.

(2) *Suspension and container.* The suspension consists of a glass fiber in the portion that is at room temperature, and several links of gold wire in the part subjected to high temperature. The glass fiber hooks into a loop under one stirrup of the balance, the pan-arrest being split to make room for the loop. Below the stone slab the whole suspension is enclosed in two telescoping glass tubes to prevent disturbance by air currents. The lower and larger tube carries at its upper end a threaded brass head which may be screwed over the brass head of the upper tube. With this arrangement the lower tube can be raised and held out of the way during any adjustment of the apparatus.

The container (B) varies in size, shape, and composition with the substance to be examined, the choice of material being influenced by the temperatures to be used. At room temperature the most satisfactory material for general use is celluloid. A bucket made by cementing sheet celluloid combines the advantages of light weight and nearly negligible magnetic susceptibility. Glass may also be used although there is always the danger of breakage to be taken into account. Glass buckets have, however, been employed with success as high as 300°C. Of the metals, iron-free brass has been found satisfactory for measurements at room temperature while gold is the best material available for high temperatures. Gold has a small susceptibility, is stable at high temperatures, and can be easily fashioned into various sizes and shapes. Platinum has too high a susceptibility, while silver changes weight through absorption or release of oxygen.

The smallest size of charge which gives the desired accuracy is the best. Containers for use at room temperature may be as large as 40 mm diameter; the height should not be greater than approximately 30 mm in order to minimize the error in estimating the magnetic field in which the specimen is suspended.

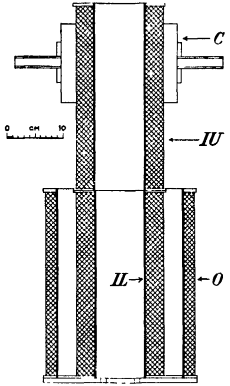

Fig 2—Arrangement of solenoids for qualitative study of the form of the magnetization curve of a ferromagnetic powder

In measurements at elevated temperatures the diameter of the bucket is limited to approximately 14 mm by the size of the furnace tube. In this case, particularly, the height should not exceed 30 mm since there is a temperature gradient as well as a field gradient along the furnace.

It is useful to provide the container with a plunger, which serves to level the surface of a powdered charge and to define exactly its dimensions.

(3) *Solenoids and electric circuits.* For measurements of susceptibility at a single field intensity the magnetic field is produced by two

coaxial solenoids (*S*) whose constants are given in Table I. The outer solenoid (*O* in Fig. 2) is wound with size No. 16 (1.291 mm) and the inner solenoid (*IL* in Fig. 2) with size No. 14 (1.628 mm) double cotton-covered copper wire.

TABLE I—DIMENSIONS OF SOLENOIDS

	Solenoid O	*Solenoid IL*	*Solenoid IU*
Total number of turns	2794	3221	3253
Number of layers of wire	14	20	20
Length, mm	320	318	319
Inside diameter, mm	226	88.5	88.5
Outside diameter, mm	265	156	156

It is frequently convenient to examine a substance in a magnetic field of variable intensity but constant gradient. This is accomplished with the aid of another inner solenoid (*IU*) similar to the inner solenoid already described (*IL*) and resting on top of it. A section is shown in Fig. 2. Since the solenoids have no cores the fields are additive. This arrangement makes it possible to examine the form of the hysteresis loop of a substance, since the field at any point can be varied from zero to maximum while the gradient (produced wholly by the outer solenoid) remains constant.[3] It is plain, however, that with a ferromagnetic powder only the qualitative form of the loop can be indicated in this way, the true magnetization curve of the material itself being unobtainable either by this or any other method.

It should be remarked here that the particular dimensions given above for solenoids and wire are not the most efficient. The solenoids were built under circumstances where their design was controlled by the available sizes of large brass tubing and also the available sizes of copper wire in pieces of sufficient length. With free choice of materials the solenoids could be redesigned either for a more intense magnetic field or for a more uniform field of force. Account must also be taken of the permissible rate of change of the field with time, because the solenoid is heated by the current and the current therefore diminishes steadily unless readjusted by manipulating the external resistances.

The inner solenoids rest on a cross-bar bolted to the under side of the bottom flange of the outer solenoid. The entire assembly of coils, whose relative positions are thus fixed, is carried by leveling screws set in the flange of the outer solenoid and resting on a brass table (*D* in Fig. 1). The height of the table is adjustable by means of a hand

[3] This arrangement was suggested by the late Dr C. W. BURROWS of the National Bureau of Standards

wheel, gear system, and screw (*G*). It has a vertical travel of 30 mm and is adjustable to 0.1 mm with the aid of an indicator on the flange and a scale on the table frame.

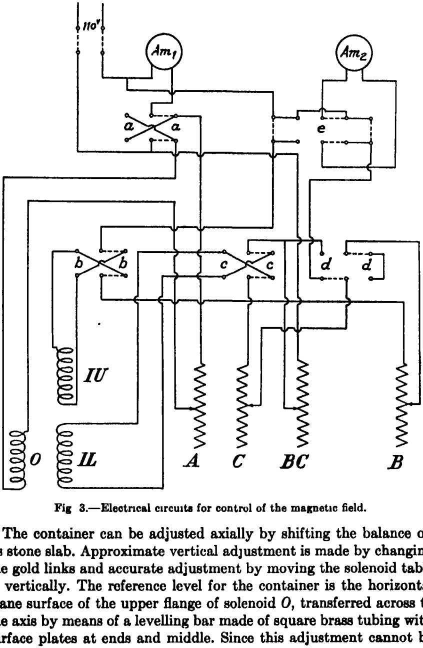

Fig 3.—Electrical circuits for control of the magnetic field.

The container can be adjusted axially by shifting the balance on its stone slab. Approximate vertical adjustment is made by changing the gold links and accurate adjustment by moving the solenoid table *D* vertically. The reference level for the container is the horizontal plane surface of the upper flange of solenoid *O*, transferred across to the axis by means of a levelling bar made of square brass tubing with surface plates at ends and middle. Since this adjustment cannot be

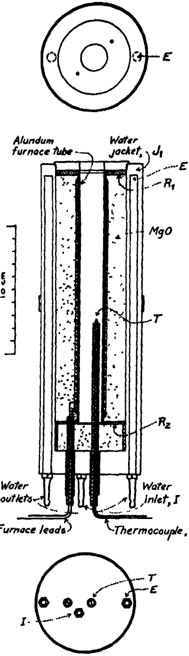

Fig. 4.—Water-jacketed furnace for the study of magnetic susceptibility to 1000°C. This furnace is inserted in place of the water-jacket shown in Fig. 1.

made when the water-jacket or the furnace is in place, it is reproduced outside the apparatus by means of a micrometer caliper set vertically in a metal block.

The handling of the heavy upper solenoid is facilitated by the use of the air lift (L) shown in Fig. 1, which consists essentially of a large brass tube fitted at its lower end with a piston. The lift can be raised or lowered by admitting air under a few pounds pressure at one valve or releasing it through the other. Attached to the tube are two arms upon which rests the carriage holding the solenoid (C in Fig. 2).

The two brass plates supporting the solenoids are perforated by a ring of holes which permit the electrical and water connections for the furnace to pass through.

The electrical circuits, including that for the upper inner solenoid, are shown in Fig. 3. When the reversing switch a is closed the outer solenoid (O) is connected to the power line through the resistance A and the ammeter Am_1. Switches b and c are reversing switches for the upper and lower inner solenoids respectively (IU and IL). Switches d are so arranged that the two inner solenoids can be connected singly or combined in series or parallel. At e there is a double-pole double-throw switch flanked by two single-pole single-throw switches, with which a second ammeter (Am_2) can be inserted into the circuit of either of the two inner solenoids or can be cut out entirely.

(4) *Furnace and control of temperature.* Since the susceptibility of most paramagnetic substances changes with temperature, some means of controlling the temperature of the container is desirable. In the neighborhood of, or but slightly above, room temperature the water-cooled jacket (J) shown in Fig. 1 is sufficient. This is nothing more than a double-walled brass cylinder through which water flows. For most purposes where close control is not necessary a small stream of water will suffice to hold the temperature within ± 0.5°C. For closer control water from a thermostat may be circulated.

For elevated temperatures, say from 50° to 1000°C, the water jacket J of Fig. 1 is replaced by the furnace shown in Fig. 4.

The core of this furnace is an Alundum tube (17 mm i.d.) upon which is wound a helical coil of 0.8 mm platinum wire (resistance = 1.092 ohm, length approximately 3.3 meter). This coil is embedded in a thin layer of Alundum cement. The winding is bifilar and the heating current is alternating, so that the furnace is without appreciable effect on the magnetic field.

The furnace tube is held in place by two Alundum plates (R_1 and R_2) which grip it at the ends. Insulation is provided by packing

powdered magnesia around the core. Heat leakage to the solenoids is prevented by the water jacket (J_1) which takes in water at the bottom (I) and discharges it through the tubes (E) which reach almost to the top. For most purposes a flow of 400 cc per minute is ample. With the furnace operating at 900°C the cooling water when flowing

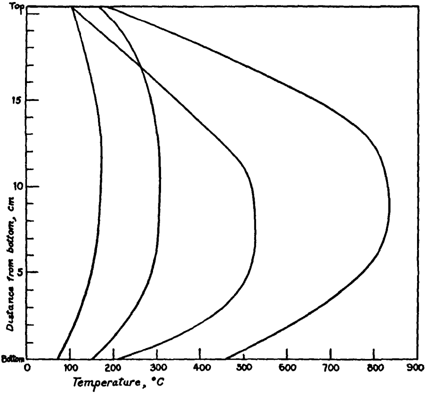

Fig. 5.—Temperature gradients inside of the furnace of Fig. 4

at this rate was raised from 23° to 30°C. The top of the furnace is covered by a divided disk of sheet zinc with a small hole at the center through which the suspension passes.

The thermocouple T is of platinum against the alloy 90 platinum, 10 rhodium, and has its junction located just below and to one side of the bottom of the container.

The upper temperature limit of the furnace is probably well above 1000°C but above this point the zone of reasonably uniform temperature becomes quite short.

The power consumed by the furnace is approximately 0.5 kilo-

watt for a temperature of 300° and slightly over 0.8 kilowatt for 800°C.

The temperature gradient in the furnace under various conditions was investigated with a small exploring platinrhodium-platinum thermocouple used in conjunction with an ice bath and a potentiometer. The results for four different conditions are shown in Fig. 5. It is apparent from these curves that while a fairly large gradient does exist near the ends of the furnace, particularly at the higher temperatures, there is always a zone approximately 30 mm long through which the temperature is reasonably constant. This zone is usually close to the center of the furnace. If care is taken to keep the container within this zone, satisfactory results can be obtained and reproduced.

The curves in Fig. 5 are all taken on an empty furnace. If the furnace contains a metal bucket it seems likely that the gradients will be somewhat reduced and that the central zone will be more uniform.

CALIBRATION OF THE SOLENOIDS

The constants of the solenoids can be obtained in two ways: (1) in absolute measure, by calculation from their dimensions; (2) empirically, by weighing the force acting on a charge of a substance of known susceptibility.

ABSOLUTE MEASURE OF SUSCEPTIBILITY

The ponderomotive force, F_s, acting in the direction X upon a small particle of a paramagnetic or diamagnetic substance in a magnetic field in vacuum, is given by the formula[4]

$$F_s = \frac{1}{2}\kappa V \frac{\partial(H^2)}{\partial x} = \kappa V H \frac{\partial H}{\partial x} \qquad (1)$$

in which κ is the magnetic susceptibility of the substance, V the volume of the particle, H the magnetic field intensity, and $\partial H/\partial x$ the field gradient in the direction X.

A more convenient constant is the specific susceptibility or mass-susceptibility, χ. If d is the density of the substance, $\chi = \kappa/d$. Then f_s, the force per gram of substance, is given by

[4] First specific statement of the principle is by W. THOMSON (Lord KELVIN) in Phil. Mag. (3) 37: 241–253. 1850; reprinted in *Papers on electrostatics and magnetism* (1872, London) pp. 500–513.

$$f_x = \chi H \frac{\partial H}{\partial x}. \tag{2}$$

If the direction X be taken as the vertical, the force can be measured by means of a balance. Then $f_x = pg$ and the expression for mass-susceptibility becomes

$$\chi = \frac{pg}{H\dfrac{\partial H}{\partial x}} \tag{3}$$

in which p is the vertical pull in the magnetic field, in grams of weight per gram of substance, and g is the force of gravity at the site of the measurement, in dynes.

GEOMETRICAL DETERMINATION OF THE CONSTANTS

The field intensity and field gradient at a given point depend only on the dimensions of the solenoids and the magnitude of the current. The field and the gradient at any point are most conveniently expressed as constants multiplied by the current.

$$H = k'I, \frac{\partial H}{\partial x} = k''I, \text{ hence } H\frac{\partial H}{\partial x} = kI^2 \tag{4}$$

in which the constants k', k'' and k depend only on the geometry of the solenoid, k being equal to $k'k''$. The formula actually used in measurements with a single solenoid then becomes

$$\chi = \frac{pg}{kI^2}. \tag{5}$$

The field-constant k' for any point M or M' on the axis of a single-layer circular solenoid (see Fig. 6) will be called k_a'. If the current is measured in amperes, and the wire is so small and so closely wound that the corrections due to its shape and helical inclination[5] are negligible, then

$$k_a' = -0.2\pi n \int_{\theta_1}^{\theta_2} \sin\theta \, d\theta = 0.2\pi n(\cos\theta_2 - \cos\theta_1) \tag{6}$$

in which n = number of turns per cm length,

[5] SNOW, C., U S Bur. Stds Sci Papers 21: 431–519 (Sci. Pap. No 537). 1926.

θ = angle subtended at M by the radius a of the solenoid.[6]
θ_1 and θ_2 are the terminal values of θ for the nearer and farther ends of the solenoid, respectively, with reference to the positive direction of the axis (see Fig. 6).

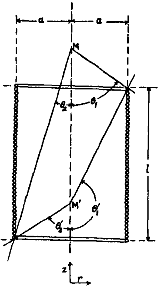

Fig 6—Geometrical quantities involved in the magnetic field of a solenoid.

For additional layers of wire a formula can be similarly developed which gives the total intensity-constant at M in terms of the inner and outer limiting radii.[7] On account of irregularities due to the necessity of providing for the anchoring and the exit of the first turns, it was found better in the present case to calculate k' for each layer and to add the values to obtain k' for the entire solenoid. The required dimensions have been given in Table I. The number of turns and the length were separately recorded for every layer during the process of winding, and the calculation of the field constant k_a' for a series of points along the axis was based on these detailed data rather than on the summarized figures given in the Table, but the details of the calculation need not be given here.

Given the curve of k_a' for each solenoid against axial distance z from

[6] This formula, originating with AMPÈRE and with BIOT & SAVART before 1825, seems to have been first written in the convenient trigonometric form by AUERBACH, in Graetz's *Handbuch d. Elektrizität u. Magnetismus* (1920) Vol. 4: 960–967. One would expect to find that this improvement had been made at a much earlier date, but we have not discovered an earlier reference.

[7] AUERBACH, p. 964 of work cited in note [6].

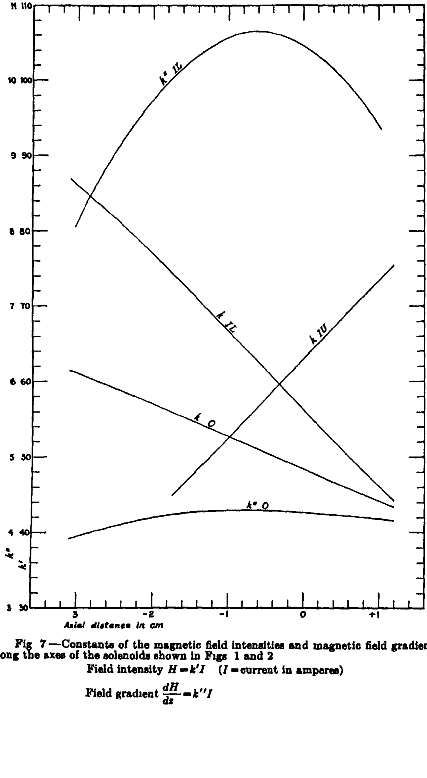

Fig 7—Constants of the magnetic field intensities and magnetic field gradients along the axes of the solenoids shown in Figs 1 and 2

Field intensity $H = k'I$ (I = current in amperes)

Field gradient $\frac{dH}{dz} = k''I$

the zero level a curve for the gradient-constant k_a'' is readily obtained graphically or with the aid of interpolation-formulas Combination of the two then gives the axial force-constant k_a Fig 7 shows these curves for our apparatus

The combined force exerted by two or more solenoids carrying different currents is proportional to the product of the total field and the total gradient When the outer and the lower inner coils are used in combination, as in most of our measurements of susceptibility in which no information on hysteresis is desired, the total force is therefore nearly twice as great as the sum of the forces exerted by each alone We have usually employed currents of 3 40 ampere in the outer and 4 50 ampere in the lower inner solenoid, the field intensity at −3 mm is then 436 gauss

For a charge of finite size the force varies both axially and radially If the depth (along the axis) is not more than 15 mm, and if the susceptibility κ is independent of H, as is true for most of the substances studied with this apparatus, the value of k_a for the middle point represents the average within the error expected

For a point near the axis the departure of k' from the axial value k_a' is given by the formula[8]

$$k' = k_a' + 0\ 15\pi n a^2 r^2 \left\{ \frac{z}{(a^2+z^2)^{5/2}} - \frac{z-l}{[a^2+(z-l)^2]^{5/2}} \right\} \tag{7}$$

in which a = radius of solenoid (single layer)

r = distance of the point from the axis

z = axial distance of the point from one end of the solenoid

l = length of solenoid

At a point distant 0 1 a from the axis, which would be about 12-14 mm for the outer solenoid and 4–8 mm for the inner, the value of k' in our apparatus differs from k_a' on the axis by only about 0 01 per cent in the worst case The axial variation is therefore negligible, even for charges of large diameter

For depths and diameters so large that the value of k at the middle point of the charge cannot be assumed to be the representative average, the formula of Boltzmann[9] gives an exact result, but the calculation is long and complicated and the empirical calibration in terms of a standard substance is usually preferable

[8] We owe the derivation of this formula to Dr Chester Snow of the National Bureau of Standards So far as we are aware it has not hitherto been published

[9] Boltzmann & von Ettingshausen, article cited in note [2]

EMPIRICAL CALIBRATION

For the empirical method crystalline ferrous ammonium sulfate, $FeSO_4$ $(NH_4)_2SO_4 \cdot 6H_2O$, is the best standard. A known weight of the powdered salt is placed in a small brass bucket and pressed down to a definite depth by means of a plunger. By suspending the bucket at various positions along the axis, with definite currents in the solenoids, the force exerted at each point can be measured, and values of K in the simple formula

$$\chi = Kp \tag{8}$$

can be calculated. As before p is the vertical pull in grams of weight per gram of substance.

Using values of χ for $FeSO_4$ $(NH_4)_2SO_4$ $6H_2O$ of 32.3×10^{-6} and 31.8×10^{-6} at 20° and 25°C, respectively, we have found that values of K for the combined inner lower and outer solenoids (IL and O), within the range -30 to $+10$ mm from the zero level (end of solenoids), agree within 1 per cent with the values of K obtained by calculation from the dimensions, as described in the preceding section.

This agreement, together with the demonstrated small axial variation in the force, justifies the empirical calibration of the apparatus for larger charges, such as can be used near room temperature in the water-jacket shown in Fig. 1. The calibration is made with a charge of powdered ferrous ammonium sulfate, corresponding in shape and volume with the unknown material, thus giving fairly high precision and accuracy to the measurements on large charges. Strictly speaking, the comparison should be made using the unknown in powdered form with the same air-filled pore space as the sulfate charge, but in these fairly homogeneous solenoid fields the error due to comparing a dense with a porous material will in most cases be negligible.

PROCEDURE IN MEASURING SUSCEPTIBILITY AT HIGH TEMPERATURES

The following notes concerning the method of taking readings may be of use to those employing similar apparatus.

The solenoids and furnace are adjusted in position so that the middle point of the charge is at the desired level, usually at -3 mm since the gradient of k at this level is small and does not change direction.

The furnace is brought to a constant temperature, usually by setting the furnace current at a predetermined value and allowing suffi-

cient time for equilibrium to be established. While with some experience and a little care a close approximation to any desired temperature can be obtained, nevertheless if it is necessary to obtain readings very close to a given temperature, it is well to attach an automatic potentiometric regulator to the furnace circuit and the thermocouple.

The routine in taking observations may be varied with the operator. One scheme which the authors have followed with success is to take readings in groups of three; first, a weighing of the sample with no magnetic field; second, after a known interval of time, a reading of the weight of the sample with known storage-battery currents through the solenoids, the currents being kept constant by adjustment of the rheostats; third, after an interval of time equal to that between the first and second readings, a reweighing without the field. The difference between the second reading and the average of the first and third gives the force exerted by the magnetic field. This procedure has been found satisfactory and appears to minimize the effects of minor or temporary fluctuations in temperature.

In some cases, the force to be measured is less than 0.1 mg or one division of the beam, using a 5 mg rider. A supplementary rider weighing only 1 mg is then used, and the readings are made by the method of swings. It is then often advantageous to leave the balance swinging throughout the set of readings.

Blank determinations should always be made on the container through the range of temperatures at which it is to be used. Celluloid (for room temperature) and gold (for higher temperatures) give the smallest blanks. One gold container, for example, weighing 5.1 gram, gave an average blank reading of +0.011 mg in the combined field at the top of the two lower solenoids.

SUMMARY

An apparatus is described which has been found useful for measuring the magnetic susceptibility of materials having a wide range of susceptibilities, at temperatures from 20° to 1000°C. A sensitive analytical balance is used to measure the force exerted upon the sample by the non-uniform magnetic field of a set of solenoids. By combining a uniform field with a non-uniform field it is possible to estimate the shape of the hysteresis loop of a ferromagnetic powder. A water-cooled furnace inserted into the solenoids serves for the higher temperatures. Calculation of the absolute intensity and gradient of the magnetic field from the dimensions of the solenoids yields constants for the apparatus which agree well with those determined

empirically by the use of ferrous ammonium sulfate as a standard substance.

CRYSTALLOGRAPHY.—*The crystal structure of calaverite.*[1] G. TUNELL and C. J. KSANDA, Geophysical Laboratory, Carnegie Institution of Washington.

The morphology of calaverite has been thoroughly investigated by a number of crystallographers.[2] Goldschmidt, Palache, and Peacock[3] concluded that calaverite crystallizes in the monoclinic system although they pointed out that an orthorhombic interpretation was not excluded with certainty by the evidence then available. They determined accurately the following values of the crystallographic elements of calaverite:[4] $a:b:c = 1.6298:1:1.1492$, $\beta = 90°08'$. Concerning the value of β they[5] wrote: "Aus diesen Messungen erhalten wir 89°52′ als besten Mittelwert des Winkels zwischen den zwei Achsen in der Projectionsebene. Dieser Winkel ist so nahe an 90°, dass die Frage, ob der Neigungswinkel von 90° verschieden ist, nicht aus den Messungen entschieden werden kann." In their comprehensive joint study of the form system of calaverite they report that it has a two-fold axis of symmetry.[6] From the statements of Penfield and Ford,[7] together with his own observations, Peacock[8] concludes that it has also a plane of symmetry. From its crystal habit, then, calaverite appears to belong to the holohedral symmetry class, $2/m$ (C_{2h}), of the monoclinic system.

Crystals of calaverite from Cripple Creek, Colorado, have been studied by the present authors by means of the Weissenberg X-ray goniometer and the two-circle reflection goniometer. The reciprocal lattice of calaverite was established by means of Weissenberg photographs taken with Cr-, Cu-, and Mo-radiation, although the crystals of calaverite were not single individuals. The structural lattice has elements strictly analogous to the fundamental morphological elements of Goldschmidt, Palache, and Peacock (their *S*-elements).

[1] Received December 8, 1934.
[2] See V. GOLDSCHMIDT, C. PALACHE, and M. PEACOCK, Neues Jahrbuch für Mineralogie, Geologie und Paläontologie, Beilage-Band 63: Abt. A, S. 50–52. 1931, and M. A. PEACOCK, American Mineralogist 17: 318. 1932, for references to previous work.
[3] Op. cit., pp 6, 7, see also M. A. PEACOCK, op. cit., pp. 324, 325.
[4] M. A. PEACOCK, op. cit., p. 325.
[5] V. GOLDSCHMIDT, C. PALACHE, and M. PEACOCK, op. cit., p. 5.
[6] V. GOLDSCHMIDT, C. PALACHE, and M. PEACOCK, op. cit., pp. 6 and 21.
[7] Am. Jour. Sci (4) 12: 286. 1901.
[8] Personal communication to G. TUNELL, dated April 25, 1934.

The dimensions of the unit cell, determined by purely röntgenographic measurements, are: $a_0 = 7.18$ Å, $b_0 = 4.40$ Å, $c_0 = 5.07$ Å, all ± 0.03 Å, $\beta = 90° \pm 30'$. Our Weissenberg films also yield decisive evidence on the question of the crystal system of calaverite. On the Weissenberg films the planes, hkl and $hk\bar{l}$, in general yield diffraction spots of very different intensity. This would not be possible if calaverite belonged to the orthorhombic system, irrespective of the space group in the orthorhombic system with which it might be isomorphous. It is therefore certain that calaverite does not belong to the orthorhombic system. The systematic extinctions of the X-ray diffraction effects on our films limit the monoclinic space groups possible for calaverite to three: $C2/m$ (C_{2h}^3), $C2$ (C_2^3), or Cm (C_s^3), the extinctions of these three space groups being identical. The density of calaverite calculated from the X-ray data is 9.31. This agrees well with the measured[9] densities and fixes the number of *molecules* of $AuTe_2$ in the unit cell as 2. The two gold atoms can only occupy the positions, 0, 0, 0, and $\frac{1}{2}$, $\frac{1}{2}$, 0, no matter which of the three monoclinic space groups listed above is that of calaverite. By means of the intensities alone all arrangements of the tellurium atoms possible in the space group, Cm, have been excluded. From the intensities it is also certain that the tellurium atoms do not occupy fixed positions or positions with one variable parameter in the space group, $C2/m$. Hence the tellurium atoms must occupy the positions, $m, 0, p$; $\bar{m}, 0, \bar{p}$; $m+\frac{1}{2}, \frac{1}{2}, p$; $\frac{1}{2}-m, \frac{1}{2}, \bar{p}$, in the space group, $C2/m$, or the positions, m, n, p; $\bar{m}, n, \bar{p}$; $m+\frac{1}{2}, n+\frac{1}{2}, p$; $\frac{1}{2}-m, n+\frac{1}{2}, \bar{p}$, in the space group, $C2$. From the intensities of the successive orders of reflection of (100) and (001) the m- and p-parameters of the tellurium atoms have been determined to be $m = 0.69$ ($2\pi m = 247°$) and $p = 0.29$ ($2\pi p = 105°$) no matter which of the two remaining space groups, $C2/m$ and $C2$, is that of calaverite. From the intensities of the other reflections the parameter along the b-axis must be close to 0. Thus the tellurium atoms occupy the positions, m, n, p; $\bar{m}, n, \bar{p}$; $m+\frac{1}{2}, n+\frac{1}{2}, p$; $\frac{1}{2}-m, n+\frac{1}{2}, \bar{p}$, where $m = 0.69$, $n = 0.00$, and $p = 0.29$, all ± 0.05.[10] The results of the intensity calculations will be given in greater detail in a subsequent communication.

[9] Cf. S. L. Penfield and W. E. Ford, Am. Jour. Sci. (4) 12: 246. 1901, Zeit. f. Kryst. und Min. 35: 450. 1901; G. F. H. Smith, Min. Mag. 13: 149. 1902, Zeit. f. Kryst. und Min. 37: 234. 1902; E. S. Simpson, Geological Survey of Western Australia, Bulletin 42: 107. 1912.

[10] The correspondence between the positive and negative senses of our axes and those of Goldschmidt, Palache, and Peacock has not been established as yet but only the correspondence between the directions of our axes and those of Goldschmidt, Palache, and Peacock.

PALEONTOLOGY.—Argyrotheca gardnerae, *new name*.[1] C. WYTHE COOKE, U. S. Geological Survey.

As the name I applied to a new brachiopod in 1919 proves to be preoccupied, I here propose the new name *Argyrotheca gardnerae*. The specific name is in recognition of the paleontologic researches of Miss Julia Gardner.

Argyrotheca gardnerae Cooke, new name

Argyrotheca dalli Cooke, Carnegie Inst. Washington Pub. **291**: 152, *pl. 16, figs. 5a–c.* 1919.
not *Argyrotheca dalli* Aldrich Bull. Am. Pal. **5**: 13, *pl. 5, figs. 9–10.* 1911.
Occurrence: St. Bartholomew, B. W. I.
Geologic horizon: Upper Eocene.
Type: U. S. National Museum, No. *167201*.

PALEONTOLOGY.—Nanicella, *a new genus of Devonian Foraminifera*[2]. LLOYD G. HENBEST, U. S. Geological Survey. (Communicated by JOHN B. REESIDE, JR.)

Through the kindness of Prof. A. K. Miller, University of Iowa, an opportunity was offered in 1932 for studying the type specimens of *Endothyra gallowayi* Thomas (Journal of Paleontology **5**: 40. 1931). A close study of the specimens confirmed a notion that I had held for some time that *E. gallowayi* belongs to a new genus, but inasmuch as the preservation of the type specimens is hardly adequate for determining the shell features with any degree of confidence, it seemed best to wait for better material. Recently, Mrs. F. B. Plummer, University of Texas, very generously shared her rich collection of topotypical material with me, and it now seems appropriate to introduce the generic name *Nanicella* for the form represented by *E. gallowayi* Thomas, which species accordingly becomes the genotype.

The name *Nanicella* refers to the reduced shape and size of the chambers in their subordination to the general architecture of the shell (Latin *nanus*, dwarf, +*cella*, chamber). In this respect, *Nanicella* resembles *Orobias*, *Nummulostegina*, and *Staffella* somewhat more than *Endothyra*. In external form it resembles *Orobias* most closely, but differs significantly from that genus by being more discoid and less involute and having a chamber morphology that is less completely subordinated to the general plan of the shell. In comparison

[1] Published by permission of the Director of the U. S. Geological Survey. Received November 15, 1934
[2] Published by permission of the Director, U. S. Geological Survey. Received December 4, 1934

with *Endothyra*, *Namcella* is considerably more advanced in regard to the degree of chamber subordination, although our present records indicate an earlier existence for *Namcella* *Endothyra* as represented particularly by *E bowmani*, the genotype, exhibits several so-called primitive traits not possessed by *Namcella* in that it is irregularly coiled, its chambers have a somewhat spherical form, and a distinct boundary between the spiral and septal walls is absent

Work is under way to make a detailed study of the shell structure

BOTANY —Sabal louisiana, *the correct name for the polymorphic palmetto of Louisiana*[1] MIRIAM L BOMHARD, U S Forest Service (Communicated by E P KILLIP)

Palmettos have always been and are today a conspicuous and familiar part of the Louisiana landscape, especially in the Mississippi Valley Accounts of early travels through Louisiana show that most of the travelers were profoundly impressed by the vegetation, and mention is frequently made of the palmettos as well as of the large cypress trees, the magnolias, the great vines, and the native cane

As early as two and a half centuries ago Le Clercq, in his account of La Salle's discovery and exploration of the Mississippi River, says, "The whole country is covered with palms "[2]

The works of Robin, Darby, and Flint, in the first quarter of the past century, give perhaps the most interesting and fullest discussions of the distribution and growth of these palmettos In 1807, Robin published an account of his travels in the New World together with a flora of Louisiana William Darby, a surveyor, after a residence of sixteen years in the State, published in 1816 the first detailed map of Louisiana, accompanied by *A geographical description of Louisiana*, which is replete with careful and accurate observations based upon an intimate knowledge of the region Flint, who resided for a time in the State, was also an accurate observer, though he acknowledges his indebtedness to Darby and others whose published works preceded his own

It is interesting to note that the French appellation, *latanier* or *latania*, which is commonly used today in Louisiana to designate the native palmettos, appears in the works of most of the early writers

[1] Received November 28 1934

[2] LE CLERCQ CHRESTIEN *Premier établissement de la foy dans la Nouvelle France*, etc 2 229 1691 Paris This is a very rare work It contains an account of La Salle s discoveries by two missionaries who accompanied him The palms were first encountered on the boat trip down the Mississippi in the territory of the Taensa Indians near the present town of St Joseph in Tensa Parish

Latanier is the French form of the native name of a group of tall, fan-leaved palms[3] indigenous to certain islands belonging to France, off the southeast coast of Africa. These palms have long been cultivated in Europe and elsewhere. The French settlers of the New World undoubtedly carried this name over to the fan-leaved palmettos in the new country, Louisiana. Flint even uses[4] the combination *Chemaerops latanier* as a scientific name for the Louisiana palmetto.

Robin gives a description of the palmettos, using vernacular names, but he offers no Latin specific names. He writes,[5]

"Louisiana produces, I believe, only two species of this family [Palmae], common in the woods; the first is the *camérope* or *palmier nain* (*Chamaerops*), commonly called *latanier*, differing from that of southern Europe in that the margins of the leaves are neither toothed nor spiny. The trunk, from which the leaves arise folded in a fan, scarcely emerges from the ground. . . . [There follows a further description of this species.]

"The second species, less common and less beautiful, divides its leaves into two portions, of which each is folded at the ends, somewhat like an old-fashioned cravat or collar."[6]

Although he offers a fairly complete botanical description of his first species, he does not describe the second beyond pointing out a peculiarity of the leaf.

Rafinesque, who translated and revised Robin's *Flora* and assigned binomial names to many of the species mentioned in it, remarks that Robin "does not appear to have been a professed botanist" and, in cataloguing the two palm species, Rafinesque simply places[7] the description of Robin's first species under *Sabal adansoni* (wrongly ascribing the binomial to Persoon instead of to Guersent) and applies a name of his own, "*Sabal ? adiantinum* Raf.," to Robin's second species, evolving a Latin description partly from Robin's remarks and, apparently, partly from conjecture, thus:

"29. *Sabal adansoni*. Pers.—*Palmier nain* ou *Latanier*. Rob. p. 337. Spadix ensiform elastic, rising seven feet, stem-like, branched, flowers trifid

[3] These palms, which have been given the generic name *Latania*, are native to the islands of Bourbon, Mauritius, and possibly, also Madagascar.

[4] "Palmetto, *Chemaerops latanier*. This is a perennial plant, strongly marking climate It commences in the same regions with long moss,—that is to say, about 33°" FLINT, TIMOTHY *A condensed geography and history of the Western States, or the Mississippi Valley* 1: 85. 1828. Cincinnati.

[5] ROBIN, C. C. *Voyages dans l'intérieur de la Louisiane . . . Suivis de la Flore Louisianaise* 3: 337–338. 1807. Paris.

[6] This is an interesting observation in view of the fact that, under certain trying growth conditions (open situations exposed to intense insolation and where the ground becomes hard and dry in the summer), the leaves of palmettos in Louisiana are often divided midway into two halves, which curve downward and away from each other.

[7] RAFINESQUE, C. S. *Florula Ludoviciana; or, A flora of the state of Louisiana.* Translated, revised, and improved from the French of C. C. Robin. pp. 16–17. 1817. New York.

white sessile odorate, blossoming in June berries like a pea, black and sweet The fibrous netting of the short caudex are used as canvas to clear and scour the leaves are used to make hats and thatch houses, etc

"30 *Sabal ? adiantinum* Raf Acaule, foliis inermis bipartitis, flabellatis, plicatis Raf —2 *Latanier* Rob p 338"

In the same work, Rafinesque includes[8] an *Appendix to the trees and shrubs of Louisiana* in which he lists and comments upon the plants appearing in Darby's work He seems to have been acquainted only with the second edition, which, although somewhat amplified, includes much the same material as the first edition, but has a different order of treatment

Darby's accounts of the topography and general vegetation of Louisiana are not only interesting but particularly clear, and, for the most part, amazingly accurate Of eight specific references to palmettos, the following is[9] of especial interest and is the one to which Rafinesque alludes

"The *Arundo gigantea* grows in immense brakes in all parts of the parish of Ascension, not liable to annual submersion Much of that majestic grass has been destroyed by the clearing of the lands, but a vast quantity still remains Along both banks of New river, in the rear of the plantations on the Mississippi, and on the banks of the Atchafalaya, are the places where most of the *Arundo* yet exists Here, as well as in every other part of Louisiana, where the land sinks too low for the *Arundo*, is found the *Chamaerops louisiana* * The latter vegetable cannot itself exist, where the inundation exceeds in depth 15 or 20 inches The land is commonly of the best quality Much of the surface of the country low upon the Mississippi, now cultivated in cotton, maize, rice, and sugar, was originally covered with the palmetto From the greater depression of the surface, the palmetto land is more difficult to reclaim, than that naturally covered with *Arundo gigantea* though equal in fertility when reduced to a state of cultivation

'The timber trees most usually associated with the palmetto, are, the *Quercus phellos*, *Quercus rubra*, *Acer rubrum*, *Acer negundo*, *Liquidambar styraciflua*, *Ulmus aquatica*, *Cornus alba* and *Celtis crassifolia* The *Quercus tinctoria*, and *Quercus virens*, are often found growing upon palmetto land, but not so frequent as the preceding The *Nyssa aquatica*, and *Cupressus disticha*, would appear from their general history, to be congenial to the palmetto land, the latter tree is sometimes found intermingled, and the

[8] ' While the Supplement of this work was under the press, the Geographical Description of Louisiana by William Darby fell into my hands Having perceived in it, several elaborate Catalogues of the trees and shrubs growing in the different parts of the State, some of which had not been observed by Robin Bartram etc and some additional geographical and economical remarks on others I have been induced to enumerate those additions for which we are indebted to Mr Darby correcting at the same time several errors of nomenclature into which he appears to have fallen '
Rafinesque op cit 157

[9] DARBY WILLIAM *A geographical description of the state of Louisiana being an accompaniment to the map of Louisiana* ed 1 193-195 1816 ed 2 81 82 1817 Philadelphia The eight references appear on the following pages in the 1816 edition 68 77 88 193 195, 205 206 216 230

former growing on inundated land adjacent to; but neither are so commonly met with on palmetto land, as might be expected.

"The palmetto may be correctly considered the vegetable that marks the limit of annual inundation. In all places where we have had good reason to consider the overflow annual, the palmetto ceased. Though able to resist partial and occasional immersion of its roots in water, we are led to believe this shrub would perish if the ground upon which it grew was subject to annual overflow This does not agree with the writer's observation.

"*[Footnote appears on p. 194 of the original text.] We have given to this vegetable the name of *Chamaerops louisiana* in the text; and are of the opinion that there is a specific difference between the *Chamaerops palmetto* hitherto known to botanists, and that of Louisiana. The *Chamaerops serrulata* of Muhlenberg is certainly not the same with the palmetto of Louisiana, the latter bears a much greater resemblance to the cabbage tree, though much more humble in elevation, than to the saw-leaved palmetto of Georgia."

Rafinesque takes sufficient note of Darby's new specific name to reprint it, but he dismisses[10] both it and Darby's interesting notes in the following manner:

"*Chamaerops Louisiana!* Palmetto or Latania! D. This Palm which Mr. Darby in a note, p. 81, thinks a new species, and to which he gives two erroneous Latin and French names, is merely the *Sabal adansoni* sp. 29. It marks the limit of annual inundation, as it grows above the reach of it."

Rafinesque, in spite of his never having seen Louisiana or its palms, did not hesitate to pass judgment upon Darby's new species. This is especially remarkable in view of Rafinesque's lack of justification for establishing *Sabal ? adiantinum* as a species. There seems to be no valid reason for his considering Darby's binomial name, *Chamaerops louisiana*, erroneous in any respect. This name appears[11] five times in the text of both the 1816 and 1817 editions and in his vocabulary of terms (immediately following the last page of the text) he lists "*Chamaerops louisiana*, . . . Palmetto, or latania." It is worthy of note that Flint later reprints[12] Darby's list of plants, as it appears in the vocabulary of terms, but without citing the source.

In another work of broader scope, Darby gives a general list of trees most likely to be found in Louisiana and adds[13] "On the banks of the streams immense brakes of *Arundo gigantea* (great cane), and on the outer margin of the cane, the palmetto or latania (*Chamaerops Louisiana*), fill the slope between the cane and the dead overflow. . . . The palmetto can support inundation a longer time and deeper than

[10] RAFINESQUE op cit 159–160

[11] DARBY. op. cit. ed 1. 194 (twice), 205, 206, 216.

[12] FLINT. op. cit 2: 486–488 Appendix, Table II.

[13] DARBY, WILLIAM *The emigrant's guide to the western and southwestern states and territories*, etc. 81. 1818 New York

the cane " This reference to the occurrence of palmettos in a zone or belt is an accurate picture of their present distribution in certain situations

In discussing Prairie Mamou (mostly included in the present Acadia Parish), Darby says,[14] "In the low grounds near the river, the palmetto, called by the French latania, abounds, but not of the gigantic size of its kindred species on the more eastern waters " This statement is doubtless to be interpreted as a comparison with the size of the *Sabal palmetto* of the Carolinas, Georgia, and Florida, which Darby recognizes as a species related to the Louisiana palmetto

A perusal of Darby's various works should convince anyone who knows Louisiana that he was thoroughly familiar with the material of which he writes His use of scientific plant names, his references, especially in footnotes, to Miller's *Gardeners Dictionary*, to Michaux, Bartram, Muhlenberg, and other botanists show that he was acquainted with the botanical literature of that time, and it seems unlikely that he would have suggested a name for the Louisiana palmetto without due consideration His descriptions and names of plants are, however, incidental to his discussions of Louisiana, which probably accounts for his giving only informal notes concerning *Chamaerops louisiana*

It is unfortunate that Darby gave no formal botanical description of this palm The following diagnosis, however, may be gleaned from his remarks concerning the Louisiana palmetto (1) It is fan-leaved—Darby refers to it as the Fan Palmetto[15] or Latania and also compares it with *Chamaerops palmetto* (*Sabal palmetto*) and with *C serrulata* (*Serenoa repens*), (2) It is unarmed, since Darby expressly states that it is "not the same" as *C serrulata* [in, not of, Muhlenberg], (3) It develops a trunk, otherwise there is no reason for saying that it is "not of the gigantic size" of the cabbage-tree, but "much more humble in elevation", (4) It is indigenous to Louisiana and a very characteristic part of the vegetation, (5) Definite localities are given for its distribution, (6) The list of associated species, including remarks concerning its association with the live oak, *Quercus virens* (*Q virginiana*), its proximity to tupelo gum, *Nyssa aquatica*, and bald-cypress, *Cupressus disticha* (*Taxodium distichum*), and its occurrence bordering the giant-cane, *Arundo gigantea* (*Arundinaria gigantea*), is adequate to cover situations in which the Louisiana palmetto grows today, (7) The definite claim is made that it is a new species allied to,

[14] DARBY *A geographical description*, etc , ed 1 88
[15] Ibid , 68

but different from, the cabbage palmetto, *Sabal palmetto*, that grows farther east. A proper binomial was used by Darby several times and in several publications.

Chamaerops louisiana Darby is the oldest name which the writer has been able to discover which is based upon palmettos growing in Louisiana. The second oldest name, similarly applied, is *Sabal adiantinum* Raf. Rafinesque is responsible for repudiating Darby's name and causing it to have been disregarded by botanists for so many years. The record in the Kew Index, oddly enough, reads "*Chamaerops louisiana* Rafin. Fl. Ludov. 159 = *Rhapidophyllum Hystrix?*" The needle palm does not occur in Louisiana.

Rafinesque, by consigning both Robin's first species and Darby's new species to *Sabal adansoni*, is the first botanist to apply that name to palmettos growing in Louisiana. To be sure, Robin's diagnosis coincides fairly well with descriptions of the acaulescent Carolina palmetto but Darby's statement that *Chamaerops louisiana* is not as tall as the cabbage-tree should, of itself, have caused Rafinesque some concern. The next year, 1818, Nuttall applied[16] Guersent's name for the Carolina plant to palmettos in Louisiana, thus: "Species 1. *S. Adansoni*. In troublesome abundance around New Orleans; but less frequent than other species in Georgia and Carolina."

Earlier botanists, including Bartram, Jacquin, Walter, Michaux, Persoon, and Pursh, ascribed the native locality of the Carolina palmetto (also called dwarf palmetto and blue palmetto) to Carolina, Georgia, Florida, or the "sea islands." The nomenclatorial history of this palmetto has been somewhat complicated, the plant having received various names both in this country and in Europe even before 1818. Seeds found their way into the Old World at an early date and it was already in cultivation abroad in the latter part of the eighteenth century. It is not the purpose of this paper to attempt to discuss the applicability of these various names to the dwarf palmetto other than to note that *Sabal adansoni* Guers. (1804) is one of the specific names which was in good standing for many years, although *S. minor* (Jacq.) Pers. is an earlier name.

Martius indicates[17] the range of *S. adansoni* as including New Orleans and the Mississippi Valley as well as Georgia and Carolina. In fact, the extension of the range of the Carolina palm to include

[16] NUTTALL, THOMAS *The genera of North American plants*, etc. 230. 1818.

[17] "Crescit gregaria in depressis arenosis udis maritimis Georgiae et Carolinae, frequens in uliginosis in vicinia fluvii Mississippi e g. propre Aureliam novam, nec non aliis in regionibus sinus floridani." MARTIUS, *Historia naturalis palmarum* 3: 246. 1838.

Louisiana and the identification of the palmettos native to Louisiana with this species and this one alone has been a common practice in floras and manuals and in various works on palms for more than a century The area covered by Chapman's flora[18] does not embrace Louisiana, the western range limit being Mississippi and Tennessee, but it should be noted that he does not even include Mississippi in the distribution of the dwarf palmetto

However, in 1926, Dr J K Small described[19] a new species, *Sabal deeringiana*, from Louisiana This is the 'palmetto-with-a-stem," the new species being based upon certain trunked palmettos in the general vicinity of New Orleans In a later paper Dr Small gives[20] a more detailed discussion of these trunked palms including illustrations of specimens of a very fine stand growing at Frenier Beach, on Lake Pontchartrain about 40 miles west of New Orleans Dr Small points out that Schott must have had trunked palms in mind when he referred[21] to a gorgeous growth in the Mississippi Valley and he quotes Schott in both his papers

Other botanists have been aware of trunked palmettos in Louisiana and have even mistaken them (as also probably did Schott) for the cabbage tree, *Sabal palmetto* the range of which is not believed to extend westward beyond St Andrew s Bay in western Florida[22] Featherman writes[23] concerning Grand Isle[24] The principal growth is live oak and yaupon in the form of low thickets A few tree palmettos are seen here and there near the beach The live oak is low and stunted and grows on a few ridges " and in his catalogue of plants in the same publication, we find

'*Sabal adansonii* Guerns Dwarf Palmetto New Orleans Orleans [Parish]
"*Sabal palmetto*, R & S [sic] Tree Palmetto Grand Isle Jefferson [Parish]

Palmettos of various ages and sizes including hundreds of trunked specimens may be seen today stretching uninterruptedly for almost

18 CHAPMAN A W *Flora of the Southern United States* ed 1 438 1860
19 SMALL JOHN K *A new palm from the Mississippi Delta* Torreya 26 33–35 1926
20 SMALL JOHN K *Palmetto-with-a-stem—Sabal deeringiana* Journ N Y Bot Gard 30 278–284 *2 figs* 1929
21 SCHOTT, ARTHUR *Substance of the sketch of the geology of the lower Rio Bravo del Norte* Part II in Emory William H *Report on the United States and Mexican boundary survey* 1 44 1857
22 SMALL JOHN K *The cabbage tree—Sabal palmetto* Journ N Y Bot Gard 24 157 1923 St Andrew s Bay is nearly 100 miles east of Pensacola
23 FEATHERMAN A *Report of botanical survey of southern and central Louisiana made during the year 1870* 25 1871 New Orleans
24 Grand Isle is a well known resort on the Gulf of Mexico about 60 miles south of New Orleans it is east of the mouth of Bayou Lafourche Access has been by boat by way of Barataria Bay until 1933 when a road was finally completed to it connecting with the road which parallels Bayou Lafourche along part of its course

30 miles from Golden Meadows nearly to Grand Isle. They occupy the slightly elevated ridge land and slope flanking Bayou Lafourche and the road, and may be numbered by the thousands.

Langlois apparently also mistakes[25] the trunked palmettos for the cabbage-tree. Because of his error, some of the earliest records of fungi parasitic on Louisiana palms have been wrongly recorded as occurring on *Sabal palmetto*.[26]

After several years of field observation of palmettos in Louisiana, especially in the vicinity of New Orleans, the writer undertook, in 1933, a detailed survey of the State with the especial aim of discovering, if possible, the distribution and relationship of the trunked and stemless palmettos. The survey was begun in May and continued into November so that flowers and fruits might be studied as well as external vegetative characters. The survey entailed a statistical study of trunked palmettos in more than 40 separate localities in Louisiana and eastward in a few stations along the Gulf Coast as far as western Florida.

Although palmettos are widely distributed over much of eastern and southern Louisiana, they attain their most luxuriant development in the southeastern portion of the State, where the trunked forms occur. Trunked palmettos are much more widespread in Louisiana at the present time than has been supposed, having been found by the writer westward nearly to Opelousas and south almost to the Gulf of Mexico. They are by no means unknown to persons intimately acquainted with the vegetation of the Lower Mississippi Valley, but are ordinarily not seen by the casual observer, since the acaulescent plants are often easily visible from the roadside whereas the trunked palmettos usually occupy the more inaccessible, wetter places beyond. Certain excellent stands of palmettos with nearly erect trunk above ground are readily accessible; e.g., at Frenier Beach, along Bayou Lafourche, and along Paris Road only 4 miles east of the city limits of New Orleans. These, however, are notable exceptions.

Moreover, the palmettos in southeastern Louisiana, at least, give every evidence of constituting a polymorphic species, which shows a remarkable response to a varying combination of habitat factors, of which water and light seem to be of the greatest significance. The writer discovered that the trunked palmettos, wherever they occur, are related to the acaulescent plants by countless transitional forms of

[25] LANGLOIS, A. B. *Catalogue provisoire de plantes phanérogames et cryptogames de la Basse-Louisiane, États-Unis d'Amérique*. p. 17, 1887. Saint-Étienne.
[26] Unpublished data of the writer

clearly intermediate character. There are situations in which a line transect, run from slightly elevated ridge land to standing water, passes through stemless, intermediate, and trunked palmettos, which show a faithful series of gradations in the size of the leaves, the number of segments, the development of filaments in the sinuses of the blade, the extent of the prolongation of the petiole into the blade, and in the height and branching of the flower stalks.

Variations in the thickness, height, and degree of branching of the flower stalks appear to be most closely correlated with leaf size and general vigor of the plant and secondarily with the presence or absence of a trunk. Variations in the size and texture of the flowers and in the size and proportions of the fruits and seeds are, as far as the writer has been able to determine, slight, and similarly traceable to growth conditions.

The tallest trunk seen by the writer was slightly over 2.5 meters in height; it was one of the palmettos in the senescent stage with reduced leaf crown and telescoped flower stalks. The average actual trunk height of these palmettos in their prime (climax form) is from 1 to 2 meters and the diameter, when devoid of leaf bases, scarcely exceeds 30 cm; with the leaf bases, the diameter may be nearly twice as great. The leaf blades may attain 2 meters in breadth and over 1 meter in length with petioles as much as 1.5 meters long. The erect flower stalks, averaging 5 cm in thickness at the base, become from 3.5 to 4.5 meters tall in the more vigorous specimens, thus making the total height of the climax form, at most, less than 7 meters.

An account of the distribution and growth of the palmettos in Louisiana together with detailed descriptions of the various forms as well as ecological data will be given in another paper.

Until the palmettos of the Southern States have been more fully studied in the field, with especial attention given to their morphological characters at different stages of growth and to the environmental factors, in addition to the study of their flowers and fruits, it cannot be definitely decided what the relationship of the dwarf palmetto is to the Louisiana palmetto, especially in the acaulescent forms. Available data, however, indicate that they are specifically distinct. The dwarf palmetto, *S. minor* (Jacq.) Pers. (*S. adansoni* Guers.), is not known to produce a subarboreal climax form (it has always, in fact, been described as acaulescent or with the caudex slightly elongated); the leaves are sparingly filamentose or without filaments, whereas the Louisiana palmetto has persistent filaments, sometimes occurring in abundance; the petiole is prolonged for only

a few centimeters into the blade, whereas in the Louisiana palmetto the prolongation may extend for as much as 40 cm. Important differences also appear in the number and width of the segments and in the size of the fruits and seeds (the Louisiana palmetto usually has a smaller fruit with a proportionately larger seed). When the erect habit is assumed, the underground portion of the Louisiana palmetto slants from the horizontal and gradually turns upward.

The palm referred to by Darby is unquestionably a species of *Sabal*, and, since *Sabal deeringiana* Small, applied definitely to Louisiana trunked palmettos, is antedated by Darby's name, the plant should be known as *Sabal louisiana* (Darby) Bomhard, comb. nov., the synonomy being as follows:

Chamaerops louisiana Darby, Geog. Descrip. Louisiana ed. 1. 194, also 205, 206, 216. 1816.

Sabal adansoni Raf. Fl. Ludov. 16. 1817, not Guersent, 1804.

Sabal ? adiantinum Raf. Fl. Ludov. 17. 1817.

Chemaerops [sic] *latanier* Flint, Condensed Geog. & Hist. West. States 1: 85. 1828.

Sabal deeringiana Small, Torreya 26: 34. 1926.

ORNITHOLOGY.—*Avian bones from prehistoric ruins on Kodiak Island, Alaska.*[1] HERBERT FRIEDMANN, U. S. National Museum.

During the summer of 1934 Dr. Ales Hrdlicka, curator of physical anthropology, United States National Museum, continued his work on Kodiak Island, and amassed, among other materials, a large collection of bird bone. A smaller lot, collected two years before, yielded so much of value that the study of the present much more extensive material was looked forward to with interest. That it has not been disappointing may be seen from the following account.

The age of the sites from which the bones were exhumed is not known with any accuracy, but they are definitely prehistoric, that is, pre-Russian (late 18th Century). This, of course, involves a span of years too short to be of significance as far as the birds are concerned, however much it may mean anthropologically. The specimens herein reported on were marked in the field according to the relative depth

[1] Published by permission of the Secretary of the Smithsonian Institution. Received November 23, 1934

at which they were found—deep, intermediate, or superficial The deeper the deposit, the older are the bones, but here again the time scale for the deposition rate is only inferential Dr Hrdlicka estimates the difference in age between the deepest and the superficial layers at about 1500 years

In order to appreciate the full ornithological significance of the collection, it was first necessary to ascertain just what kinds of birds were known to occur on Kodiak Island A search of the literature revealed how little work has been done there, especially considering its size and proximity to the mainland of Alaska No paper dealing exhaustively with the avifauna of Kodiak appears to have been published, this I hope to do in the near future for the benefit of other students of Alaskan ornithology as all the data are now assembled before me

The present collection contains bones of 40 species of which 7 have not been recorded in literature before from Kodiak Island These are as follows

Diomedea nigripes	Black-footed Albatross
Cygnus buccinator	Trumpeter Swan
Chen rossi	Ross's Goose
Nyroca affinis	Lesser Scaup
Glaucionetta clangula	Golden Eye
Haliaeetus albicilla	Gray Sea Eagle
Stercorarius longicaudus	Long-tailed Jaeger

In Dr Hrdlicka's 1932 collection, reported on in an earlier paper,[2] were bones of 8 other species that were unrecorded in literature from Kodiak Island Of these, 5 are also represented in the present collection These 8 are

Gavia immer	Common Loon
Phalacrocorax carbo sinensis	Chinese Cormorant
Clangula hyemalis	Old Squaw
Arctonetta fischeri	Spectacled Eider
Melanitta deglandi	White-winged Scoter
Melanitta perspicillata	Surf Scoter
Bubo virginianus algistus	Saint Michael Horned Owl
Surnia ulula caparoch	American Hawk Owl

Thus, in two summers' excavating, in a field to one side of the major work of the expeditions, no fewer than 15 species have been added to the recorded avifauna of Kodiak Island Inasmuch as the total bird population, as far as recorded, comprises about 125 forms, we must credit nearly one-eighth of them to osteological records

[2] FRIEDMAN H This JOURNAL 24 233 236 1934

The following annotated list deals only with the 1934 collection.

GAVIA IMMER (Brünnich). Common Loon.

Two metacarpals were found in the superficial layer. On the basis of geography, these records should refer to the lesser loon, *Gavia immer elasson*, but the races are not to be told with certainty from the bones.

GAVIA ADAMSI (Gray). Yellow-billed Loon.

This large loon was represented in all three depths, the superficial stratum yielding a synsacrum, a tibiotarsus, and a tarsometatarsus; the intermediate depth revealed a metacarpal; a metacarpal and a tarsometatarsus come from the deepest layer.

GAVIA ARCTICA PACIFICA (Lawrence). Pacific Loon.

Represented by a single metacarpal from the deepest layer.

GAVIA STELLATA (Pontoppidan). Red-throated Loon.

A tarsometatarsus from the superficial stratum and a metacarpal from the deepest layer represent this species.

COLYMBUS AURITUS Linnaeus. Horned Grebe.

A tarsometatarsus from the intermediate depth and a humerus from the superficial stratum are the only bones of this grebe found.

DIOMEDEA NIGRIPES Aububon. Black-footed Albatross.

This species, represented by a femur from the deepest layer, 3 femora from the intermediate area, and by 5 femora, 1 synsacrum, and 1 tarsometatarsus from the superficial layer, has not been previously reported from the island.

PHALACROCORAX PELAGICUS Pallas. Pelagic Cormorant.

The bones of this species show great variation in size; if only the two extremes were present, one might think them different species. This cormorant is one of the common birds on Kodiak Island and it is represented by numbers of bones as follows: deepest layer, 5 tarsometatarsi, 4 tibiotarsi, 3 coracoids, 6 femora, 4 humeri, 7 ulnae; intermediate layer, 13 tarsometatarsi, 11 tibiotarsi, 8 coracoids, 21 femora, 18 humeri, 21 ulnae; superficial layer, 2 tarsometatarsi, 10 tibiotarsi, 4 coracoids, 16 femora, 8 humeri, and 11 ulnae.

On the basis of geography these specimens should be of the typical race, *Ph. p. pelagicus.*

CYGNUS COLUMBIANUS (Ord) Whistling Swan

The whistling swan is represented by a ' thumb" phalanx found in the superficial layer

CYGNUS BUCCINATOR Richardson Trumpeter Swan

The intermediate depth revealed 2 right coracoids and the head of a humerus of this bird The humerus was notably large, somewhat greater in size than any specimen available for comparison It had the shaft cut off and had been worked by the early Eskimos as a beveled edge had been made around the cut surface The superficial layer yielded a fragmentary humerus

PHILACTE CANAGICA (Sevastinaoff) Emperor Goose

The emperor goose is represented by a coracoid from the deepest stratum

ANSER ALBIFRONS (Scopoli) White-fronted Goose

A metacarpal, found in the intermediate layer is of this species

CHEN ROSSI (Cassin) Ross's Goose

A single ulna from the superficial layer represents this species which is new to the Kodiak fauna The previous record[3] is erroneous, the bone, a skull, is found, on further study to be that of a black brant, *Branta nigricans*

ANAS PLATYRHYNCHOS Linnaeus Mallard

The mallard is known to breed in the Aleutian Islands and the whole Alaskan peninsula, so its occurrence on Kodiak is wholly to be expected, and the scarcity of previous records must be looked upon as solely due to lack of observation and work in that place It is represented in the present collection by 54 humeri, of these 3 come from his deepest layer, 16 from the intermediate depth, and 35 from the superficial stratum

DAFILA ACUTA (Linnaeus) Pintail

The pintail is represented by 25 humeri, 3 from the deepest, 5 from the intermediate, and 17 from the superficial layers These bones probably refer to the American subspecies *tzitzihoa*

NYROCA AFFINIS (Eyton) Lesser Scaup Duck

Four humeri, 1 from the intermediate, and 3 from the super-

[3] This JOURNAL 24 234 1934

ficial layers, are the only evidence of this duck's occurrence on Kodiak Island.

GLAUCIONETTA CLANGULA (Linnaeus). Golden-eye.

Of this duck the intermediate layer yielded a coracoid; the superficial stratum a syrinx, a skull, and 2 humeri. By virtue of geography the bones should be referred to the American subspecies, *G. c. americana*. The species is new to the Kodiak avifauna, as far as published records go.

CLANGULA HYEMALIS (Linnaeus). Old Squaw.

This duck is represented in all three depths, as follows: deepest layer, 1 humerus, 2 coracoids, intermediate area, 8 humeri, 2 coracoids, superficial layer, 12 humeri, 3 coracoids.

HISTRIONICUS HISTRIONICUS (Linnaeus). Harlequin Duck.

A single coracoid of this duck was found in the superficial layer. It is undoubtedly of the western race *pacificus*.

POLYSTICTA STELLERI (Pallas). Steller's Eider.

Bones of Steller's eider were found in all three depths. The deepest layer revealed 2 humeri; the intermediate layer yielded 9 humeri; the superficial stratum produced 14 humeri, 1 coracoid, and 1 tarsometatarsus.

SOMATERIA V-NIGRA Gray. Pacific Eider.

The Pacific eider is represented by a sternum and a metacarpal from the deepest layer, 3 metacarpals from the intermediate layer, and 2 skulls, 3 tarsometatarsi, and 2 metacarpals from the superficial deposits.

SOMATERIA SPECTABILIS (Linnaeus). King Eider.

This is one of the most abundant waterfowl on Kodiak Island, if we may judge from the number of its bones found. The deepest layer yielded 13 humeri, 1 metacarpal, 4 ulnae, and 3 tarsometatarsi; the intermediate depth produced 17 humeri, 5 metacarpals, 3 ulnae, and 7 tarsometatarsi; from the superficial layer were taken 46 humeri, 2 sterna, 1 skull, 11 ulnae, 2 femora, and 7 tarsometatarsi.

MELANITTA DEGLANDI (Bonaparte). White-winged Scoter.

The collection contains 56 bones of this duck, distributed as follows: deepest layer, 2 coracoids, 3 metacarpals, 6 femurs; intermediate layer, 1 humerus, 1 coracoid, 2 metacarpals, 19 femora; superficial layer, 1 skull, 3 metacarpals, 18 femora.

MELANITTA PERSPICILLATA (Linnaeus). Surf Scoter.

The surf scoter is represented by a femur from the deepest layer, 7 femora and a tibiotarsus from the intermediate stratum, and 6 femura, 3 tibiotarsi, 2 skulls, and 2 sterna from the superficial deposits.

OIDEMIA AMERICANA Swainson. American Scoter.

A coracoid and 2 humeri from the intermediate layer, and a coracoid and 6 humeri from the superficial stratum are of this species.

HALIAEETUS ALBICILLA (Linnaeus). Gray Sea Eagle.

This eagle is represented by 2 tarsometatarsi and 1 metacarpal from the surface deposits. It is not only a new bird for Kodiak Island, but is the fourth known record for North America, the others being from Unalaska, Cumberland Sound, and off the coast of Massachusetts.

HALIAEETUS LEUCOCEPHALUS (Linnaeus). Bald Eagle.

The bald eagle is abundant on Kodiak Island and is well represented in the present collection. From the deepest layer come 2 humeri, 2 coracoids, 1 clavicle, 1 scapula, 2 tarsometatarsi and 3 metacarpals; from the intermediate stratum are 1 synsacrum, 2 humeri, 3 femora, 4 coracoids, 4 tibiotarsi, 1 scapula, 4 tarsometatarsi, and 11 metacarpals; from the superficial layer are 2 sterna, 4 fragments of synsacra, 12 skulls or fragments of skulls, 10 humeri, 15 femora, 6 coracoids, 10 tibiotarsi, 2 ulnae, 1 scapula, 10 tarsometatarsi, and 12 metacarpals.

THALASSOAETUS PELAGICUS (Pallas). Steller's Sea Eagle.

This fine eagle was previously known from Kodiak Island on the basis of one record, a bird shot there on August 10, 1921 by C. H. Gilbert.[4] It is of interest to find that bones referable to it are included in the present collection, as follows: from the deepest layer 2 humeri, from the intermediate layer, 1 synsacrum (fragment), 2 humeri, 1 metacarpal, 2 tarsometatarsi, 1 caracoid, 2 tibiotarsi, and 1 claw; from the superficial layer, 1 sternum, 1 synsacrum (fragment), 1 pair of mandibles, 2 metacarpals, 2 ulnae, 1 tarsometatarsus, 4 femora, and 3 tibiotarsi.

GRUS CANADENSIS (Linnaeus). Little Brown Crane.

This bird has been recorded but once previously from Kodiak Island. It is represented in the present collection by a radius from the

[4] Condor 24: 66. 1922.

intermediate area, a coracoid, a tarsometatarsus, and an ulna from the surface deposits.

STERCORARIUS LONGICAUDUS Vieillot. Long-tailed Jaeger.

Three humeri from the intermediate and superficial layers represent this species. It is new to Kodiak Island.

LARUS GLAUCESCENS Naumann. Glaucous-winged Gull.

A good number of bones of this gull were found, as follows: in the deepest layer, 1 humerus, 2 ulnae, 3 femora, 2 tarsometatarsi and 4 metacarpals; from the intermediate layer, 6 humeri, 2 tibiotarsi, 1 coracoid, 2 femora, and 9 metacarpals; from the superficial layer, 4 humeri, 1 coracoid, 1 femur, 2 tarsometatarsi, and 11 metacarpals.

LARUS ARGENTATUS Brunnich. Herring Gull.

From the deepest layer 1 metacarpal was collected; from the intermediate depth came 4 humeri, 1 coracoid, 1 tarsometatarsus, and 9 metacarpals; from the superficial layers 2 humeri, 1 coracoid, 2 tarsometatarsi, and 2 metacarpals were collected. The bones may refer to the race *smithsonianus*, or to *thayeri*, or even to *vegae*!

LARUS CANUS BRACHYRHYNCHUS Richardson. Short-billed Gull.

This gull is represented by 3 tarsometatarsi from the superficial layer.

URIA AALGE CALIFORNICA (Bryant). California Murre.

URIA LOMVIA ARRA (Pallas). Pallas's Murre.

Bones of these two murres are practically indistinguishable and accordingly I have had to treat them together. Both species are very common on Kodiak Island and both are undoubtedly present in the following series of bones. From the deepest layer, 57 humeri, 1 skull, 1 tarsometatarsus, 1 tibiotarsus, 26 ulnae, 2 metacarpals, 10 femora; intermediate layer, 53 humeri, 3 skulls, 1 synsacrum, 1 tarsometatarsus, 2 tibiotarsi, 18 ulnae, 3 metacarpals, 6 femora; from the superficial layer, 43 humeri, 1 sternum, 7 skulls, 1 clavicle, 15 ulnae, 5 coracoids, 6 metacarpals, 12 femora.

CEPPHUS COLUMBA Pallas. Pigeon Guillemot.

This bird is represented by 2 ulnae from the deepest deposits and 2 ulnae and 2 humeri from the surface layers.

CYCLORRHYNCHUS PSITTACULA (Pallas). Paroquet Auklet.

Of this auklet there are 14 humeri, 7 from the deepest, 3 from the intermediate, and 4 from the superficial layers.

LUNDA CIRRHATA (Pallas). *Tufted Puffin.*

The tufted puffin is represented by bones from all three depths, as follows: deepest layer, 3 humeri and 3 ulnae; intermediate layer, 2 humeri, 1 femur, 1 metacarpal, and 6 ulnae; superficial layer, 1 sternum, 1 humerus, 1 femur, 2 ulnae, and 1 tibiotarsus.

PICA PICA HUDSONIA (Sabine). American Magpie.

One femur from the deepest layer; 1 humerus from the intermediate stratum; and 2 skulls, 1 tarsometatarsus, and 1 femur from the superficial layer refer to this species.

CORVUS CORAX PRINCIPALIS Ridgway. Northern Raven.

The raven is common on Kodiak Island and is well represented in the present collection as the following list shows. From the deepest layer, 1 skull, 1 humerus, 3 ulnae, 1 tibiotarsus, 3 metacarpals, 1 coracoid, and 4 tarsometatarsi; from the intermediate layer, 6 humeri, 6 ulnae, 1 radius, 6 tibiotarsi, 5 metacarpals, and 1 tarsometatarsus; from the superficial layer, 3 skulls, 8 humeri, 7 ulnae, 5 tibiotarsi, 11 metacarpals, and 4 femora.

CORVUS BRACHYRHYNCHOS CAURINUS Baird. Northwestern Crow.

The small, northwestern crow is a common inhabitant of Kodiak Island. Its bones were found in all the layers of the excavations, as follows: from the deepest stratum, 2 femora, 1 tibiotarsus, and 3 ulnae; from the intermediate depth, 6 femora, 4 tibiotarsi, and 2 ulnae; from the superficial layers, 1 skull, 5 humeri, 3 femora, 5 tibiotarsi, and 17 ulnae.

SCIENTIFIC NOTES AND NEWS

Prepared by Science Service

NOTES

Science Advisory Board.—Through the Science Advisory Board, created by presidential executive order last year, scientists not on the Government payroll have been active in the reorganization of the work of not less than six bureaus in various departments of the Federal Government, under the program authorized by act of Congress early in 1933. They have also advised on the scientific problems confronting a number of independent Government agencies not connected with any special department.

Major revisions and extensions of program were contemplated by the Government in the Weather Bureau and the Bureau of Chemistry and Soils of the Department of Agriculture, in the National Bureau of Standards of the Department of Commerce, and in the Bureau of Mines, the Geologi-

cal Survey, and the Soil Erosion Service of the Department of the Interior. In all these studies the Science Advisory Board participated by invitation of the Government; and it was also invited to take part in such diverse non-departmental matters as the modernization of railroads, the study of peoples' fitness for new jobs, and the unearthing of valuable archaeological data from mounds and other Indian sites in the Tennessee valley before they were drowned forever under the backwaters of the new dams.

Many of the tasks of the Board are already finished. The first one, which was indirectly responsible for the creation of the Board, was the reorganization of the U. S. Weather Bureau. This has been completed, and we are on the way toward a better knowledge of the weather and its practical forecasting. The saving of the old Indian records, which necessarily had to be done rapidly, is also a closed job.

Some of the Board's tasks are still in progress. Notable among these is the work of the committee on land use, and also the development of better coordination between the numerous separate mapping agencies of the government.

Some of the Board's activities are of necessity continuing projects, since they concern problems that either have no end, or at least will require decades of work to close them up. Such are the decentralization of industry and the application of scientific knowledge to the technical and medical problems of the Army and Navy.

The first report of the Science Advisory Board tells of progress during its first year of existence. Government officials are in general agreement with prominent scientists, that the Board has proved an effective mechanism for making available to the country its own resources in scientific knowledge.

More Research Called For.—Vigorous support for a program of fundamental scientific research featured Secretary WALLACE's annual report to President ROOSEVELT. In normal times it enables farmers, stockmen and foresters to get the best returns from the land with the least outlay in money and labor. And in the present period of emergency a number of hitherto undermanned research projects have been enabled to go ahead by turning the efforts of unemployed men and women against some of the very ills that made them jobless.

"Research is the Department's biggest job; indeed, research is the foundation of everything it does," Secretary WALLACE declares. "It could not help farmers to plan their production, to reduce their costs, to fight the diseases and pests that attack animals and plants, to produce better crops and livestock, and to market their products efficiently, without first studying how these things may be done."

The frequently-offered criticism, that research increases crops just when the Department is trying to reduce surpluses, the Secretary combats as a fallacy. By discarding the benefits of science, crops could be reduced, he admits, but it would be at the cost of wasted labor and exhausted land resources. The right method of control, he insists, is first to reduce unit costs of production, and then adjust the number of units produced to the capacity of the market to absorb them.

Smithsonian Institution.—A camp site abounding in Folsom-type culture remains was discovered in an arroyo in Colorado by Dr. FRANK H. H. ROBERTS, JR., of the Bureau of American Ethnology. The finds consisted not only of Folsom points but of the cores from which they were struck, as well as bones split for marrow and charcoal hearths, indicating permanent

occupation. This represents the first known Folsom *settlement*. The site has not yet been explored, but only prospected.

An expedition into the jungles of Panama, led by DR. WILLIAM D. STRONG, has produced culture remains believed to be of great importance in tracing the history of the development and migrations of indigenous American cultures. The finds, consisting of star-headed stone warclubs, pottery, and human figurines, all show South American affinities.

A fossil vertebra of a veritable sea serpent, picked up at Belvedere Beach, Va., by Dr. W. GARDNER LYNN of the Johns Hopkins University, has been turned over to the U. S. National Museum. It represents a new species of *Paleophis*, a swimming python-like snake perhaps 25 feet long It has been described under the name of *P. virginianus* by C. W. GILMORE.

The present revival of gold mining in Mexico has been of indirect benefit to the U. S. National Museum; a large quantity of specimens of rare minerals, including livingstonite and vesuvianite, has been obtained from mines in the southern part of that country by Dr. W. F. FOSHAG, curator of minerals.

Pan-American Union.—Surgeon General H. S. CUMMING and Dr. B. J. LLOYD, Director and Assistant Director, respectively, of the Pan American Sanitary Bureau, were two of three delegates of the United States at the Ninth Pan American Sanitary Conference, held in Buenos Aires, November 12–22, 1934. Dr. JOHN D. LONG, Traveling Representative of the Bureau, also attended.

Dr. A. A. MOLL, scientific Editor of the Pan American Sanitary Bureau, gave a lecture before the Johns Hopkins Medical History Club on *Physicians in public life, especially in Latin America.*

Surg. Gen. H. S. CUMMING has been re-elected Director of the Pan American Sanitary Bureau of the Ninth Pan American Conference.

The Cuban Government has just granted the Finlay decoration to Dr. L. O. HOWARD, former Chief of the U S. Bureau of Entomology; Brig. Gen. J. R. KEAN, and Dr A. A. MOLL. The latter is the author of a biographical essay on Finlay.

New officers of the Washington, D. C. Chapter of the Pan American Medical Association are Dr. HENRI DE BAYLE, Charge d'Affaires of Nicaragua, President, Surg. Gen. ROBERT U PATTERSON, Vice President, and Dr. A. A. MOLL, Secretary.

National Bureau of Standards.—The many friends of Dr. PAUL R. HEYL will be glad to learn that he has returned to his work at the Bureau after a remarkably rapid recovery from his serious accident last October.

Dr. H. C. DICKINSON addressed the student section of the American Society of Mechanical Engineers at George Washington University on the evening of December 5. His subject was *An invitation to clear thinking about the organism which controls the distribution of work and wealth in civilized society.*

Dr. H. C. DICKINSON presided at the traffic session of the engineering and industrial research division, Highway Research Board on December 6. This session formed part of the fourteenth annual meeting of the Board which was held at the National Academy of Sciences, Washington.

Terrestrial Magnetism Observations.—The United States Coast and Geodetic Survey and the Department of Terrestrial Magnetism of the Carnegie Institution of Washington are making a joint attack on the problems of more rapid and convenient absolute magnetic observations and of more con-

sistent performances of variometers for vertical intensity at observatories. The program includes exhaustive tests of existing instruments and development of new ones particularly electrical methods of recording, with the special aim of a combination of accuracy, rapidity, and convenience which has not as yet been attained by other methods.

STUART L. SEATON, of the Department of Terrestrial Magnetism, sailed from New York November 15, 1934, for Watheroo, Western Australia, where he will join the staff of the Magnetic Observatory operated by the Department at that place. He will pay especial attention to ionospheric research. En route he will call on various officials in Australia who are interested in the work in which he will be engaged.

Cause of Stratosphere Balloon Failure.—Because the giant stratosphere balloon, Explorer, on its ill-fated flight in July had the lower part of its rubber-sticky fabric tucked up inside the balloon, great tears occurred which brought a precipitate ending to the flight. This was the finding of a scientific inquiry as to the cause of the accident made by a board of review consisting of Dr. L. J. BRIGGS, Chairman, National Bureau of Standards, Dr. JOHN O. LA GORCE, National Geographic Society, Brig. Gen. O. WESTOVER, U. S. Army Air Service, Dr. W. F. G. SWANN, Bartol Research Foundation, and Dr. L. B. TUCKERMAN, National Bureau of Standards, as reported by Dr. BRIGGS and Dr. TUCKERMAN.

To avoid difficulty in inflation and launching, great folds of fabric that would not be expanded by gas until the balloon had risen about 60,000 feet in its 75,000 foot projected climb were accordion folded inside with the idea that as the bag increased in size in the rarefied atmosphere it would come loose neatly. But the designers did not realize that the new way of folding would not allow the adherent rubber-coated fabric to peel loose, as happens with the usual method of folding. The inside layers became taut first, setting up shearing stresses that broke the fabric. So at 60,000 feet, the tears began and forced a descent. An explosion of the lifting hydrogen gas mixed with air oxygen admitted by the torn balloon was the final act in the disaster and caused the disintegration of the balloon.

The Fight for the Elms.—With the $527,000 of PWA funds, Department of Agriculture forces fighting the elm disease have moved into the area around New York City, to start a campaign of extermination against all trees found to be harboring the disease or the beetles that carry its causal fungus. In the wooded country, men of the CCC will cut down and destroy the sick and dead elms. In the cities, workmen under the direction of experts will take out the doomed trees, sawing them limb by limb as they stand rather than felling them, to avoid damage to telephone and electric wires as well as to buildings. This greatly increases the cost of removal, but the expense cannot be avoided.

An area with a radius of some 45 miles around New York City is known to harbor the diseased trees. Elimination must be made complete in this region, or the disease will start over again. In addition, a ten-mile "safety zone" outside the known infested area is also marked for cleaning up. In all, 5,000 square miles, containing 3,000,000 trees, must be policed.

Self-Reporting Earthquakes.—Earth's rigid rocks, and its iron core, proved faster messengers of the Chilean and Honduran earthquakes than did the wires man strings along the surface. The Honduran earthquake occurred on the night of Sunday, December 2. Early on Monday morning telegrams began to arrive in Washington, informing the U. S. Coast and

Geodetic Survey and Science Service of the records traced on seismographs of observatories all the way from Tucson, Ariz., to San Juan, P. R., and making possible the location of an epicenter in Honduras. Only on Tuesday, December 4, did meager reports trickle through a patched-up communication system to tell the world of wreckage in the interior of the Central American country.

Similarly, instrumental reports of the Chilean earthquake were in the hands of seismologists some hours before telegraphic reports of damage in the northern mountain provinces came through.

The instrumental reporting of earthquakes is maintained through a cooperative arrangement of the U. S. Coast and Geodetic Survey, Science Service, the Jesuit Seismological Association and numerous universities in the United States and abroad.

NEWS BRIEFS

Approximately 1800 lots of seed, mostly of grasses and other plants of sand and soil-binding value, have been brought back from Russian Turkestan and Asiatic Turkey by H. L. Westover and C. R. Enlow of the U. S. Department of Agriculture. They represent the fruits of a seven months' expedition.

The Bureau of Entomology, U. S. Department of Agridulture, expects a severe outbreak of chinch bugs in the central grain areas in 1935, but anticipates less trouble from grasshoppers than there has been during the past few years.

PERSONAL ITEMS

A bronze plaque, the annual award for meritorious service in the fields of medicine and science given by the New Jersey Health and Sanitary Association, was presented in absentia on November 16 to Dr. Theobald Smith, formerly of the U. S. Department of Agriculture.

One of the outstanding honors that can be won by students of the life sciences, the Joseph Leidy medal, has been given to Gerrit Smith Miller, Jr., of the U. S. National Museum, by the Academy of Natural Sciences of Philadelphia. The Leidy medal is awarded for distinguished work in the natural sciences. In announcing the selection of Mr. Miller as its fourth recipient, the committee cited "his extensive and fundamental studies on the structure, classification, distribution and evolution of the mammals."

Dr. H. E. Ewing, entomologist in the Bureau of Entomology and Plant Quarantine, has accepted an invitation to deliver ten lectures to the class in medical entomology at the Johns Hopkins University School of Hygiene and Public Health.

Dr. Charles Armstrong, attached to the National Institute of Health, U. S. Public Health Service, has recovered from a three weeks' attack of an unknown illness, which may have been an attack of encephalitis. He has been conducting research on that disease continuously since the epidemic in St. Louis in 1933.

Prof. H. M. Johnson of American University lectured at Yale University on Friday evening, November 23, and at the University of Virginia on Friday evening, December 8.

Dr. S. F. HILDEBRAND, senior ichthyologist of the U. S. Bureau of Fisheries, has been elected to honorary membership in the Panama Canal Natural History Society in recognition of his contributions to the knowledge of neo-tropical ichthyology.

Assistant Director CONRAD L. WIRTH, in charge of the branch of planning and the State Park Division, U. S. National Park Service, has been named chairman of the Committee on National, State and Provincial Parks of the American Institute of Park Executives.

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PHARMACOLOGY —*The relationship between time of administration and effectiveness of remedies for cyanide poisoning* [1] James F Couch, H Bunyea, and A B Clawson, Bureau of Animal Industry

In the studies previously reported[2] it appeared that promptness in administration of the remedy in cyanide poisoning was an important factor in protecting the animal against a fatal outcome Data as to just how soon the remedy must be given were lacking, however, and it was with the idea of supplying some definite information on this point that the experiments reported in this paper were conducted We had previously shown that the combination of sodium nitrite and sodium thiosulphate is the most effective remedy for cyanide poisoning in both cattle and sheep, and that it is possible to protect against

TABLE 1 —Effect of Varying Interval Between Drenching with 1 5 m l d of Cyanide and Giving the Remedy

Date 1934	Sheep No.	Weight kg	Time from end of drench: to first symptoms	to collapse	to giving remedy	Remedy	Effect
Aug.			min	min	min		
29	1493	43 6	1	1 5	11 5	1g nitrite & 2g thiosulphate	Died
29	1537	45 9	1 5	1 75	7 5	do	Died
29	1487	39	0 5	2	12	do	Survived
29	1485	39	1	2 5	12 5	do	Died
29	1480	34 45	1	2	3	do	Survived
29	105A	39 5	1	1 5	9 5	do	Died
29	1509	43 1	1 5	1 75	8 75	do	Died
29	1488	45 45	1 5	3	8	do	Died
30	1467	40 8	1	1 5	32 5	do	Survived
30	1479	41 2	2	4	18 5	do	Survived
30	1482	31 7	1 5	2 5	4	do	Survived
30	1526	37 5	1 5	3	5	do	Died
30	100A	35 8	1 5	2	6	do	Died
30	101A	34 9	1	2	7	do	Died
30	1519	35 8	1	3	5	do	Died
30	1484	36 2	1	2	5	0 5 g methylene blue	Died
30	103A	34 9	1 5	2	7	do	Died
30	1500	39 9	1	2	7	do	Died
30	1466	48 07	1	2	4	do	Died

[1] Received January 3 1935

[2] This Journal 24 369-385 528-532 1934

2 m.l.d. of potassium cyanide in cattle and 2.75 m.l.d. in sheep. It remained to determine how soon after the cyanide was given the remedy must be injected in order that the animal might survive. This paper records only the results obtained with sheep.

The results are summarized in table 1. Nineteen experiments were performed with sheep of which 15 were given 1g of sodium nitrite and 2g of sodium thiosulphate in water solution, and four were given 50 c.c. each of 1 per cent methylene blue solution for comparison. As previously described the potassium cyanide was given by mouth. The dose of cyanide given was calculated to equal 1.5 m.l.d. or just high enough to ensure death in all cases and yet much smaller than the upper limit of possible protection (2.75 m.l.d.). The remedy was administered intraperitoneally at varying times following the completion of the drenching. The animals exhibited the first symptoms, accelerated respiration, in from ½ to 2 minutes after the drench, averaging 72 seconds, and collapsed in 1.5 to 4 minutes after the drench averaging 132 seconds. Dyspnea was present in all cases at the time the remedies were injected and was very marked in the delayed cases.

Three cases were encountered in which the course of the poisoning was atypical. Sheep No. 1487 after showing symptoms in ½ minute and collapsing in 2 minutes after the drench, showed improvement, recovered consciousness, rolled upon the sternum and remained there. Six minutes later the sheep began to show dyspnea and one minute after was breathing with considerable difficulty. She was then given the combination remedy 12 minutes after the drench. Forty-eight minutes after the injection of the remedy she rose to her feet and shortly appeared fully recovered.

Sheep No. 1467 behaved similarly. After collapsing the sheep remained down for 1.5 minutes and then got to her feet and remained standing for 20 minutes before lying down. The animal developed symptoms of dyspnea and 32.5 minutes after the drench was very sick. She was then given the remedy and improved, got on her feet in 51 minutes and recovered. Sheep No. 1479 likewise got to her feet after collapsing and remained standing for 6 minutes when she went down and became dyspneic. In 18.5 minutes after the drench the sheep was very sick. She was given the remedy, got back on her feet in 21 minutes and recovered.

In the other cases more regularity was observed. There was a progressive development of symptoms without periods of improvement before the remedy was injected. When 3 and 4 minutes only had elapsed

between the completion of the drench and the administration of the nitrite-thiosulphate combination the sheep recovered. A longer interval was followed by death. As methylene blue has been recommended as a remedy, for purposes of comparison 4 sheep were treated with 50 c.c. of 1 per cent solution intraperitoneally at 4, 5, 7, and 7 minutes after the completion of the drench and all died.

SUMMARY

The combination of 1 gram sodium nitrite and 2 grams of sodium thiosulphate used as a remedy in cyanide poisoning is effective when administered promptly. The combination protected when injected intraperitoneally within 4 minutes after drenching an average sized sheep with 1.5 m.l.d. of potassium cyanide, but did not protect after a longer interval except in the cases of unusually resistant sheep. One half of a gram of methylene blue in solution similarly administered did not protect in 4 minutes. Three sheep out of 19 showed atypical behavior when poisoned with the cyanide.

ZOOLOGY.—*A new species of* Oochoristica *from a skunk.*[1] MARY SCOTT SKINKER, Bureau of Animal Industry. (Communicated by E. W. PRICE.)

Members of the genus *Oochoristica* are found in a wide range of vertebrate hosts, but they occur most frequently in reptiles. Meggitt (1934) gave a comparative table of most of the species of the genus; he did not include 5 species described by Harwood (1932) or *O. parva* (Sandground, 1926) Meggitt, 1934. He explained that the omission of *O. parva* was due to the fact that no description was available, and it is probable that none was available for the species described by Harwood. The description of *O. thapari* Johri, 1934 from *Calotes* sp. has been published since Meggitt's paper appeared. Of the species included in Meggitt's table, 5 (including *O. parva*) are from carnivore hosts. These 5 species and the one described in this paper represent the known species from carnivores; a comparative table of these is included.

Family ANOPLOCEPHALIDAE Cholodkowski, 1902
Subfamily LINSTOWINAE Fuhrmann, 1907
Genus OOCHORISTICA Luehe, 1898

Generic diagnosis.—Genital pores usually unilateral, only infrequently irregularly alternating. Genital ducts passing between or dorsal to longitudinal excretory vessels Longitudinal excretory vessels variable in number,

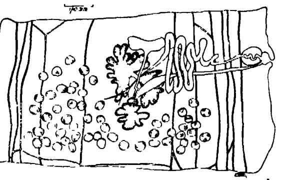
[1] Received November 6, 1934

frequently with secondary ramifications. Testes numerous, i.e., usually more than 10. Female reproductive organs median; uterus a transverse tube breaking up into egg capsules, each containing a single egg. Adults in primates, carnivores, insectivores, edentates, marsupials, and reptiles; larval stages unknown.

Oochoristica mephitis, n. sp.

Scolex.—Maximum diameter 429 to 689μ; suckers usually somewhat longer than wide, only rarely circular in outline, 159 to 220μ long by 130 to 183μ wide.

General anatomy of strobila.—Length of gravid strobila 11 to 25 mm.; width usually variable, up to 1 3 mm. Neck (unsegmented region) present or absent according to state of contraction, if present usually only slightly



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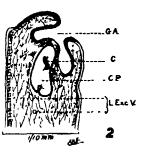

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Figs 1-2 —*Oochoristica mephitis* Fig 1 —mature segment Fig 2 —Region of genital atrium Drawn from cross section C, cirrus, C. P, cirrus pouch, G A, genital atrium, L Exc V, longitudinal excretory vessel

narrower than greatest diameter of scolex Segments about 40 to 70 in number in strobilae with fully developed oncospheres, immature segments 20 to 40 in number, the posterior 5 to 10 segments showing only testes (i.e., ovary not yet developed); fully mature segments 2 to 10 in number, usually about 3, these usually widest of strobila; gravid segments 7 to 23 in number, usually narrower than mature segments and usually longer than wide, sometimes approximately square; in a specimen 11 mm. long, gravid segments 715μ square. Genital papillae about one-third segment length from anterior margin in mature segments, usually in middle of segment margin in gravid segments Genital atrium (Fig. 2) conspicuous, variable in shape, usually about 35 to 40μ in greater diameter. Longitudinal excretory canals inconspicuous and difficult to demonstrate in whole mounts, variable in number and arrangement, usually 4 to 6 (Fig. 1) on each side, most laterally situated canals usually about 110μ from segment margin; transverse canals irregular in arrangement (Fig 1) but tending to form a somewhat definite posterior canal in each segment. Longitudinal muscular layer poorly developed; transverse muscles scattered, few in number. Calcareous corpuscles few in the material available.

Male reproductive system.—Testes 44 to 77 in number, sometimes slightly oblong, size varying with stage of development, actively functioning testes up to about 40μ in greater diameter, distributed posterior and lateral to

ovary with tendency toward distribution in two groups in mature segments, poral group smaller, testes not extending laterad beyond most lateral excretory canal. Cirrus pouch usually extending nearly to most lateral longitudinal excretory canal, usually approximately spherical, 55 to 65μ in diameter, sometimes slightly greater in the diameter which lies along transverse axis of strobila. Vas deferens without coils in early development, in wide coils in mature segments, sometimes disappearing abruptly in early gravid segments, usually still visible in terminal segments, passing along the middle of ventral surface of ovary.

Female reproductive system—Ovary at first distinctly bilobed, later variable in shape, but with tendency toward crescentic outline. Oviduct (Fig 3) passing from middle of posterior margin of ovary to vagina, surrounded

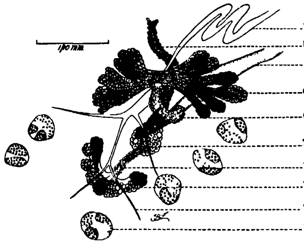

Fig 3 *Oochoristica mephitis* Details of median reproductive organs Ovary not fully developed

by large nucleated cells. Vitellarium at first crescentic in outline, later usually irregular in outline, composed of numerous lobules made up of cells slightly smaller than those of ovary, vitelline duct surrounded by large nucleated cells. "Shell gland" (Fig 3) approximately globular in shape, composed of (or surrounded by?) large cells. In a gravid specimen 11 mm. long with about 40 segments, other measurements as follows: Typical mature segment 1.23 mm. wide by 0 65 mm long; ovary about 192μ long and 192μ wide; shell gland about 40μ in diameter, vitellarium about 92μ in diameter Ovary not developing until after testes are well developed, ovary then developing rapidly and disappearing abruptly at appearance of first eggs in uterus. Uterine stem passing from "shell gland" along longitudinal axis of segment to a point approximately parallel to anterior edge of ovary, surrounded by relatively large nucleated cells; with further development, uterine stem (Fig 3) bifurcating anteriorly and forming a transverse tube, the tube eventually breaking down and egg capsules filling entire segment. Vagina without coils, opening posterior to opening of cirrus sac Seminal receptacle conspicuous, about 145μ to 185μ long by 43μ to 50μ in maximum width, dorsal to poral lobe of ovary, frequently visible along with vas def-

TABLE 1.—THE SPECIES OF OOCHORISTICA FOUND IN CARNIVORES

Species	Length (in mm.)	Width (in mm.)	Diameter of scolex (in μ)	Diameter of suckers (in μ)	Length of cirrus pouch (in μ)	Extent of cirrus pouch	Testes, number and arrangement	Seminal receptacle	Diameter of egg (in μ)	Relation of genital ducts to excretory vessels	Hosts and locality
amphisbeteta Meggitt, 1924	15–40	0.45–0.50	210	165	111	Beyond lateral excretory vessel	22–24, posterior to ovary	Absent	30	Between, dorsal to nerve	*Herpestes auropunctatus* (Hodgson, 1836); India.
herpestis Kofend, 1917	60	3	290	—	220	To ventral excretory vessel	50–60; posterior and lateral to ovary, in 2 layers dorsoventrally	—	57×32	Dorsal	*Herpestes sanguineus* Rüpp.; Africa (Soudan). *Atelerix spiculus* (Thomas and Wroughton, 1907), *A. spinifex* Thomas, 1918, Africa (Nigeria)
ichneumontis Baer, 1924	100	4	—	—	200	To nerve	99–100, posterior and lateral to ovary, extending beyond excretory vessels, in single layer	Absent	46 (oncosphere 30)	Dorsal	*Herpestes gracilis* (Rüpp.) *Galerella gracilis* (Ruppell, 1835); Union of South Africa. "*Foetorius* sp." [? Ictonyx sp.], Africa (Rhodesia).
incisa Railliet, 1899	10–150	1.3	270–600	80–120	100–130	(No drawing available)	23–50, posterior and lateral to ovary	Small	30 (oncosphere 23μ)	Between	*Meles meles* (Syn. *M. taxus* Schreb.); Europe (France) *Crocidura caerulea* (Kerr, 1792); Asia.
mephitis n. sp.	11–25	1.3	429–689	159–220 by 130–183	55–65	To lateral excretory vessel	44–75, posterior and lateral to ovary, in one irregular layer	Present	30	Dorsal	*Mephitis elongata*, United States (Georgia).
parva (Sandground, 1926) Meggitt, 1934	1.3–10.6	650–750	750	140	90	Beyond lateral excretory vessel	40–60, posterior and lateral to ovary, several between vagina and vas deferens	Present	24×21	Dorsal, ventral to nerve	*Nasua socialis*; Brazil.

erens in terminal gravid segments. Eggs, when containing fully developed oncospheres, about 30μ in diameter.

Hosts.—Definitive: *Mephitis elongata;* intermediate: Unknown.

Location.—Small intestine of definitive host.

Distribution.—United States (Georgia).

Type specimen.—United States National Museum No. 32859, collected by Dr. Eloise Cram of the Zoological Division.

Specific differentiation.—The present writer considers the number and arrangement of testes, the size of the cirrus pouch and its position with reference to the other genital organs and especially to the excretory canals and nerve, the presence or absence of a seminal receptacle, the type of genital atrium, i.e., whether massive or with relatively little musculature, the relative position of the genital ducts and excretory canals, and the size of the egg the best characters for specific differentiation. *Oochoristica mephitis* may be separated from the other members of the genus by comparison of the species with regard to these characters as shown in Meggitt's table. In some cases such as *O. cryptobothria* (Linstow, 1906) La Rue, 1911 the description is so inadequate as to prevent comparison, but where relatively complete descriptions are given, one or more of the characters listed above will serve to separate all species from *O. mephitis*. The accompanying table gives only the species found in carnivores, and in it *O. mephitis* may be distinguished from *O. amphisbeteta* and from *O. ichneumontis* on the basis of the presence of a seminal receptacle in *O. mephitis;* in *O. amphisbeteta* the testes are distributed lateral to the most lateral excretory canal, whereas in *O. mephitis* no testes lie outside the most lateral excretory canal. *O. herpestis* is a much larger worm than *O. mephitis* and the eggs also are larger. The conspicuous seminal receptacle in *O. mephitis* separates it from *O. incisa* which, according to Baer (1927), has only a very small one, and in *O. incisa* the genital ducts pass between the excretory vessels, while in *O. mephitis* they pass dorsal to the excretory vessels. *O. parva* may be distinguished from *O. mephitis* by the testes in the former having a distribution (see table 1) quite unlike that in the latter, and by the cirrus pouch in the former extending well past the excretory vessels, the musculature of the genital atrium of the former also serves to differentiate it from other species. Meggitt (1934) pointed out that the number of testes and the size of the cirrus sac vary, and should, therefore, be regarded as not infallible specific characters. The present writer finds that an accurate count of testes can be made only in young segments before the testes have developed to a size which results in crowding. In *O. mephitis* the writer does not find the variation in the size of the cirrus pouch greater than the normal limits of variation for such a character. It is, therefore, considered a relatively constant character. Meggitt cautioned against accepting unquestioningly the measurements of eggs and oncospheres since they vary according to the medium in which the eggs are measured. The measurements here given are for eggs mounted in balsam.

The characteristic appearance of these specimens is that of thin, nearly translucent worms, with the width usually greatest in the region of the mature segments, and the transition from mature segments to gravid segments so rapid as to seem abrupt.

Discussion of table 1.—Meggitt (1934) considered *O. amphisbeteta* Meggitt, 1924 a synonym of *O. erinacei* Meggitt, 1920, but in the opinion of the present writer both these specific names are probably synonyms of *O. incisa* Railliet, 1899. Joyeux (1927) considered *O. incisa* very similar to *O. erinacei* and described the egg capsules of *O. erinacei* var. *rodentium* as 45μ in diameter with the oncosphere 23μ by 17μ. Marotel (1899) described the egg capsules of *O. incisa* as 45μ in diameter and the egg itself as 35μ by 22μ with the hooks of the embryo as 17μ long. Meggitt (1934) did not give the egg size of either *O. erinacei* or *O. amphisbeteta*. Baer (1927) gave the diameter of the eggs of *O. erinacei* as 15μ, and that of the eggs of *O. amphisbeteta* as 30μ. With such conflicting data it is difficult to come to any conclusion other than that the measurement "15μ" given by Baer is probably a typographical error. The number of testes recorded by Meggitt (1924) for *O. amphisbeteta* is 22 to 24 and for *O. erinacei* is 30 to 50, but it is probable that these were counted in mature segments only, and judging from the variation found by the present writer in young segments of *O. mephitis* in which the testes could be accurately counted, variations from 22 to 50 is not beyond specific limits. It is on the authority of Baer (1927) that *O. amphisbeteta* is described as being without a seminal receptacle and *O. incisa* as having a small one. It seems quite possible, since Meggitt fails to state definitely that the seminal receptacle is absent in *O. amphisbeteta*, that a small one may be present but demonstrable only in sections or in well extended segments. However, Meggitt described *O. erinacei* as being without a seminal receptacle, and since he later came to regard *O. amphisbeteta* as a synonym of *O. erinacei* for the present both species must be considered as lacking this structure.

The specimens of *O. incisa* which were but 10 mm. long were regarded by Baer as a *forma minor*.

The massive musculature of the genital atrium of *O. parva* (Sandground, 1926), Meggitt, 1934, appears to be a specific character which would serve to separate this species from other members of the genus. The specific name *parva* was proposed by Baylis (1929) for a member of the genus *Oochoristica*, but when *Atriotaenia parva* Sandground, 1926 was identified as belonging to the genus *Oochoristica*, it created the necessity of renaming *Oochoristica parva* Baylis, 1929. Dr Baylis has suggested, in correspondence which the present writer had with him, that if necessary *Oochoristica parva* Baylis, 1929 be renamed *Oochoristica lygosomatis*, and he indicated his willingness to have the new name published by anyone in a position to express a definite opinion that Sandground's species is a member of the genus *Oochoristica*. Since *Oochoristica parva* (Sandground, 1926), Meggitt, 1934 possesses no

characters which serve to separate it from the genus *Oochoristica*, the present writer proposes the new name *O. lygosomatis* for *O. parva* Baylis, 1929.

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ZOOLOGY.—*A new species of amphipod of the genus* Grandidierella *and a new record for* Melita nitida *from Sinaloa, Mexico.*[1] CLARENCE R. SHOEMAKER, U. S. National Museum. (Communicated by MARY J. RATHBUN.)

In 1923 Mr. W. E. Chapman, American Consul, at Mazatlan, Sinaloa, Mexico, sent some amphipods to the U. S. National Museum which were taken by Mr. Harry Notton in connection with the shrimp investigations which he was carrying on at Mazatlan. The material contained two species, *Melita nitida* Smith, which is reported for the first time from the west coast of America, and a species that I believe to be new to science and which I designate as *Grandidierella nottoni.*

GRANDIDIERELLA Coutière, 1904

The first species of this genus, when described by Giles in 1888, was placed in the genus *Microdeutopus* with which it, however, did not agree by the possession of a uniramous third uropod. Coutière in 1904, when he described his new species, *mahafalensis*, created the genus *Grandidierella* to receive it, and considered its affinities closer to the *Corophiidae*, in which family he placed it. Coutière, and later Stebbing in 1908, called attention to the close alliance of *Grandidierella* with both *Unciola* and *Cheirreuxius*, and Stebbing placed his new species, *G. bonnieri*, in the *Corophiidae*. Chilton (1921, p. 549) said, "The

[1] Published by permission of the Secretary of the Smithsonian Institution Received December 8, 1934

general resemblance of the animals to *Microdeutopus* and to *Aora* is so great that in my opinion the genus should be placed under the *Aoridae*. The third uropods certainly are one-branched, but I do not consider this sufficient to outweigh the resemblance in all other characters which, as will be seen from the following description, is very close." He lays particular stress upon the resemblance of the first gnathopods of the male, the uropods, and the telson to those of *Microdeutopus*. Schellenberg (1925, p. 164) calls attention to the very indefinite limits of the family *Corophiidae* as established by Stebbing in *Das Tierreich*, and suggests the alteration of the family *Aoridae* to include genera with either biramous or uniramous third uropods in order to include the genus *Grandidierella*.

In comparing *Grandidierella* with the genera now placed under the *Corophiidae*, there appear to be so many characters in common that it seems more natural to include it in this family rather than to alter the *Aoridae* for its reception. *Grandidierella* is depressed, possesses a very strongly developed second antenna in the male, has very small side-plates which are not in continuity, and has the third uropods uniramous. These characters are very strongly emphasized in *Grandidierella elongata* Chevreux (1925, p. 393, fig. 32) and in the present species, and are also possessed by the genera *Corophium*, *Unciola*, and *Siphonoecetes*. *Chevreuxius*, *Ericthonius*, *Neohela*, *and Unciolella* are depressed with small disconnected side-plates, and have uniramous third uropods, but without the strongly developed second antenna. *Camacho* is depressed and has the small disconnected side-plates, but has a minute second ramus to third uropods. *Cerapus* is depressed, has the separated side-plates, and uniramous third uropods, but has the first antennae strongly developed. In the genera *Cerapus*, *Corophium*, *Ericthonius*, and *Siphonoecetes*, the second gnathopods are larger than the first, but in *Neohela*, *Unciola*, *Chevreuxius*, and *Unciolella* the first gnathopods are larger than the second. In the genera *Chevreuxius*, *Unciolella*, and *Grandidierella* the first gnathopod of the male is strongly developed and very similar in structure, the fifth joint being enlarged with a short, transverse palm defined by a strong tooth at the lower distal extremity. The second gnathopods in these three genera are very similar in structure, being weak, slender, and subchelate. In the species of *Grandidierella* here described, besides other points of resemblance, the fifth or last peraeopod and the second antenna of the male bear a very close resemblance to *Corophium*; the fourth and fifth joints of this antenna bearing the characteristic distal tooth of that genus.

Chevreux (1925, p. 392), when describing his species, *G. elongata*, placed it in the family *Corophiidae*.

In view of the foregoing considerations, it would seem more natural to place *Grandidierella* with other closely related genera in the family *Corophiidae* rather than alter the characters of the family *Aoridae* to accommodate it.

Grandidierella nottoni, n. sp.

Male.—Head with lateral lobes well developed and bearing the ill defined, black eye. Antenna 1 with first joint stouter, but a little shorter than second, third joint about one-third the length of second, flagellum nearly

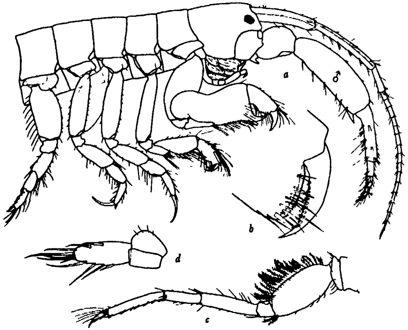

Fig. 1.—*Grandidierella nottoni*, new species, male *a*, anterior portion of animal *b*, end of gnathopod 2, greatly enlarged *c*, peracopod 5, same scale as *a*. *d*, uropod 3, greatly enlarged.

as long as peduncle and composed of fifteen joints, accessory flagellum minute, about half the length of the first joint of primary flagellum. Antenna 2 robust, but slightly shorter than antenna 1, first and third joints very prominent and strongly developed, fourth joint very strongly developed and nearly twice as long as fifth, flagellum shorter than fifth joint and composed of two long joints and four shorter joints The fourth and fifth joints of the second antenna of the male bear a distal tooth, thus completing the very close resemblance of this antenna to that of the male *Corophium*. The mouthparts bear a very close resemblance to those figured by Coutière (1904, p. 5, figs. 6–9) for *G. mahafalensis*. Gnathopod 1 is very robust and strong, the fifth joint being produced backward into a very prominent rounding lobe

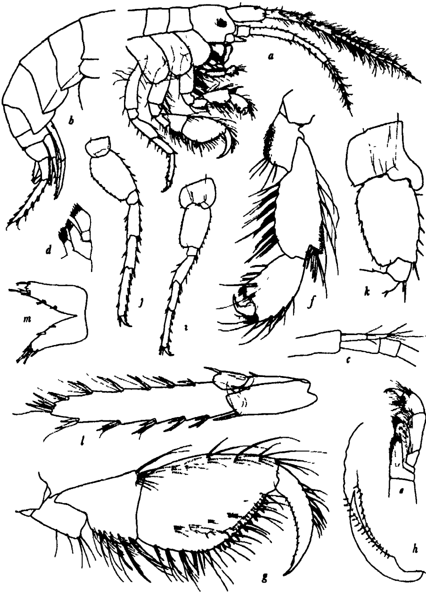

Fig. 2—*Melita nitida* Smith, male from Mazatlan. *a*, anterior portion of animal *b*, posterior portion of animal. *c*, accessory flagellum, greatly enlarged. *d*, maxilla 1 *e*, maxilliped *f*, gnathopod 1. *g*, gnathopod 2 *h*, inside of gnathopod 2 showing shallow groove bounded by spines into which the dactyl fits. *i*, peraeopod 3, same scale as *a* and *b*. *j*, peraeopod 5, same scale as *a* and *b*. *k*, peraeopod 4 of female *l*, uropod 3 *m*, telson

much as figured by Chilton (1921, p. 550, figs. 10,n and 10,o) for *G. megnae* but there is not the slightest suggestion of a forward-pointing tooth in the center of the palm either in young or old individuals, nor is the small tooth figured by Chilton (1921, p. 550, fig. 10,e) on the posterior margin of the fifth joint present in any of these specimens from Mazatlan; the prominent tooth on the sixth joint of Chilton's figures (1921, p. 550, figs. 10,n and 10,o) is not present in any of my specimens. Gnathopod 2 bears a close resemblance to Chilton's figure (1921, p. 550, fig. 10,g), except that in the present specimens the second joint is comparatively longer and slenderer and the palm is more nearly transverse. Peraeopods 1 and 2 bear a close resemblance to those of the genera *Microdeutopus* and *Corophium*, but the seventh joint is as long as the sixth, as in *Corophium*. Peraeopods 3 to 5 increasing consecutively in length, peraeopod 5 closely resembling that of *Corophium*, the second joint bearing posterior plumose marginal setae. Side-plates all very shallow, narrower than their respective segments and not in continuity. Pleon segments 1 to 3 with postero-lateral corners broadly rounding. Uropod 1 extending back slightly farther than 2, and the peduncle without a stout spine at distal extremity, as figured by Coutière (1904, fig. 17) for *G. mahafalensis*. Uropod 2 extending back very slightly farther than 3. Telson wider than long, distally truncate, and having a small seta at either lateral corner.

Length.—Male about 7 mm.

The female in general like the male. Antenna 2 not so strongly developed, but the lower lateral margin of the head deeply incised to receive the enlarged first peduncular joint as in the male. The fourth joint of antenna 2 bears on the lower inner margin a distal forward-pointing spine and another similar spine nearer the proximal end. In younger females the distal spine only appears to be present. Gnathopod 1 not much larger than 2 and simply subchelate, the oblique evenly convex distal margin of the sixth joint forming the palm against which the seventh joint exactly fits. Gnathopod 2 like that of the male, though somewhat proportionately shorter Peraeopods and uropods as in the male. Female about as long as male.

Type.—Male, taken at Mazatlan, Sinaloa, Mexico, February, 1923, by Harry Notton; water brackish, salinity, 13 5 per mill. U S.N.M. Cat. No. 69742.

Chilton demonstrated that *Grandidierella megnae* (Giles) was subject to great variation in some of its characters, and concluded that *G. mahafalensis* Coutière and *G. bonnieri* Stebbing were synonyms of Giles's earlier species. Later authors have adopted Chilton's view. Recently Dr. Stephensen (1933, pp. 434 and 446) has reported *G. megnae* as being extremely common in shallow salt-water pools, and in cisterns, on the islands of Bonaire and Curaçao off the coast of Venezuela.

As neither young nor old males of the present Mexican specimens show any vestige of a central palmar tooth, nor a tooth on the under side of the sixth joint of gnathopod 1, and as Chilton's figure (1921, p. 550, fig. 10,c) of the second antenna of a mature male does not show the *Corophium*-like development of the present specimens, I have concluded that they represent a new species.

The collection of the U. S. National Museum contains specimens of what I believe to be *G. megnae* (Giles) from two new localities from the West Indian region.

The first lot, consisting of males and females, was taken in February, 1933, by Mr. R. M. Bond from Étang Saumâtre, a brackish lake of Haiti. The largest male, measuring about 5 mm. in length, has in gnathopod 1 only the rudiment of the central palmar tooth, no lower marginal tooth on fifth joint, and no tooth on the under margin of the sixth joint. The largest female with eggs bears on the lower inner margin of the fourth joint of antenna 2 four evenly placed forward-pointing spines. These spines are quite conspicuous, but apparently have not been mentioned in any of the descriptions heretofore.

The second lot consists of three male specimens taken from the stomach of a flounder at Tortugas, Florida during the summer of 1933 by Dr. Harold W. Manter. The largest of the specimens has the first gnathopod nearly as figured by Chilton (1921, p. 550, fig 10,f). It bears the small central palmar tooth and the small marginal tooth on the lower margin of the fifth joint, but lacks the tooth on the under margin of the sixth joint as does Chilton's. The two smaller specimens bear the central palmar tooth, but not the small tooth on the lower margin. The largest specimen only retains one of the second antennae which appears to be much slenderer than that figured by Chilton (1921, p. 550, fig. 10,a). The first antenna of this male is considerably longer than the second and proportionately much slenderer than that figured by Chilton (1921, p. 550, fig. 10,a). The largest of the specimens measures about 3.5 mm.

As far as we can learn from the published records of the genus *Grandidierella*, it appears to inhabit mainly brackish waters. Tattersall records it from fresh water in China, Stephensen from slightly saline cistern water in Bonaire Island. The specimens from Tortugas, however, were found in the ordinary water of the Gulf of Mexico in the vicinity of the Gulf Stream. The species here described, *G. nottoni*, was taken in brackish water, salinity 13 5 per mill.

MELITA NITIDA Smith

This species was described by Prof. S. I Smith in 1873 from the coast of New England. Since then it has been reported from widely separated localities along the east coast of the United States as far south as Louisiana, by Paulmier (1905, p. 162), Holmes (1905, p. 505), Pearse (1912, p. 371), Fowler (1912, p. 187), and Kunkel (1918, p. 99).

The present specimens taken in February, 1923, by Mr. Harry Notton are the first to be recorded from the west coast of America. In 1933 Dr. Waldo L. Schmitt, while a member of the Hancock Galapagos Expedition, collected specimens at La Plata Island, Ecuador; Cocos Island, southwest of Costa Rica; and Bahia Honda, Panama.

In west coast specimens the flagellum of antenna 1 is a little shorter than the peduncle and not longer, as Smith (1873, p. 560) records of the New England specimens. The fourth joint of antenna 2 is slightly longer than the second joint of antenna 1 and not scarcely shorter, as stated by Smith. The seventh joint of gnathopod 1 of the male projects inward nearly at a right angle to the sixth joint, as recorded by Smith, but this joint is perfectly developed to fit the palm, so it is probable that the animal has the ability to close it against the palm if necessary. In gnathopod 2 of the male, the dactyl closes against a row of short spines on the inside surface of the sixth joint. As in Smith's specimens, the fifth pleon segment bears posteriorly a row of three or four short spines on either side of the median dorsal line.

In the female the sixth side-plate has the lower front corner produced into a peculiar and characteristic lobe much as that of *Melita palmata* (Montagu).

The largest specimens that I have seen from the west coast of America measure about 6 mm., while Smith gives 7–9 mm. for the New England specimens.

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ENTOMOLOGY.—*A new species of blister beetle from Arizona.*[1] GUIDO G. MAYDELL.[2] (Communicated by HAROLD MORRISON.)

Epicauta crassitarsis, n. sp.

Reddish pitchy brown, clothed with luteous or cinereoluteous pubescence; on each elytron a whitish longitudinal line. Head black, shining, coarsely but sparsely punctate and clothed with a sparse pubescence; median line distinct; eyes large, feebly emarginate anteriorly, coarsely granulated; antennae dark brown, the first joint enlarged apically, reddish except the apex and provided with rather long cinereous hairs, the second joint with the basal half reddish, the third joint elongated not quite as long as the first two combined, the following decreasing in length and somewhat flattened apically. Prothorax subquadrate, a little longer than wide, parallelsided in three-fourths of the length; median line distinct, punctation and pubescence the same as on the head. Elytra parallelsided, finely punctate-granulate; on each elytron a narrow median line of lighter pubescence not quite reaching the apex; the sutural, apical and lateral margins also whitish. Abdomen and sterna black, the legs reddish, both sparsely clothed with cinereous pubescence. The hind tibial spurs stout, acuminate to the tip. Length 10–11 mm.

Male.—Anterior tibiae with a single short and curved terminal spur. The tarsi of the intermediate legs with the three basal joints bulb-like, enlarged; the first joint the largest and curved in its basal half.

Female.—The anterior tibiae bicalcarate; the tarsi of the intermediate legs normal

Type.—Male, Tempe, Ariz, Sept 7, 1933, K. B. McKinney (4–145); 3 paratypes, 1 male, 2 females, labelled in the same way, all in the collection of the U S National Museum, Washington, D C.

[Just before his death a supplementary series of this species, 20 specimens, was received from the same source, but collected by Mr. McKinney on alfalfa Sept 20, 1934, about a year after the type series above described Mr. Maydell unfortunately had no opportunity to reconsider his first draft based on only the four above listed types H. S B]

ZOOLOGY.—*New nematodes of the genus* Longistriata *in rodents.*[3] G. DIKMANS, Bureau of Animal Industry. (Communicated by MAURICE C. HALL.)

Longistriata musculi, n sp Figs. 1–7.

Specific diagnosis.—*Longistriata* Worms small, with anterior end of body usually coiled in a loose spiral Cephalic cuticle slightly inflated and marked with annular striations, inflation extending for a distance of 65 to 75μ; beyond this point a cuticular expansion marked by longitudinal striae in-

[1] Received December 3, 1934

[2] During the few days before his sudden death on September 28, 1934, Mr Maydell had been adding to his manuscript revision of the Meloid genus *Epicauta* from the data assembled in the U S National Museum The abrupt termination of his labor leaves this revision uncompleted Among his last written additions the following description of a peculiar southwestern species about which he had spoken with much interest is complete and ready for publication H S Barber

[3] Received December 11, 1934.

creasing in number from anterior to posterior end. Immediately posterior to cervical inflation longitudinal striae numbering about 6 to 8; in posterior portion striae numbering about 18 to 20, all striae being marked by fine cross striations. Head rounded; mouth and circumoral papillae inconspicuous. Esophagus 320 to 450μ long by 30 to 40μ wide in its terminal portion. Nerve ring near middle of esophagus. Excretory pore near beginning of posterior fourth of esophagus.

Male 3 25 to 4 5 mm. long by 95 to 100μ in maximum diameter immediately anterior to bursa Bursa relatively large and symmetrical. Ventroventral ray shortest and slenderest, and externo-dorsal longest and thickest, of paired rays, remaining paired rays about equal in size; tips of rays approximately equidistant at margin of bursa except for postero-lateral and externodorsal, these rays approximated to each other. Dorsal ray divided into 2 branches in its distal third, each branch again dividing near tip, external branch of second bifurcation longer than inner branch Spicules 390 to 420μ long, straight and filiform, with triangular enlargement at distal ends. Gubernaculum absent.

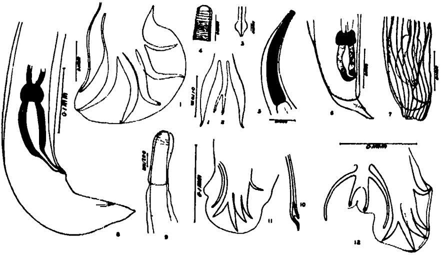
Female 4 25 to 6.75 mm. long and about 100 to 160μ wide in region of proximal portion of ovejector. Ovejector single, stout, muscular, about 100μ long. Vulva to anus, 90μ; anus to tip of tail, 30μ. Eggs 55 to 60μ long by 30 to 32μ wide

Host.—*Mus musculus.*

Location.—Small intestine.

Locality.—Jeanerette, Louisiana, U. S. A.

Type specimens.—U. S. National Museum Helminthological Collection No. 30456.



Figs 1–7.—*Longistriata musculi.* Fig 1. Lateral view of bursa Fig 2 Dorsal rays of bursa. Fig 3 Terminal portion of spicules. Fig 4 Anterior portion of head. Fig. 5. Anterior portion of body. Fig 6 Posterior portion of body of female, showing ovejector. Fig. 7 Posterior portion of body of female, showing longitudinal striations of cuticle.

Figs. 8–12.—*Longistriata norvegica* Fig. 8 Posterior portion of body of female, showing ovejector Fig. 9 Anterior portion of body, showing cuticular inflation Fig. 10. Terminal portion of spicule Figs 11 and 12 Bursa.

Longistriata norvegica, n. sp. Figs. 8–12.

Specific diagnosis.—Longistriata: Worms small, usually coiled in a loose spiral. Cervical inflation characteristic of this group of nematodes, about 75 to 80μ long by 25 to 30μ wide, the anterior widest portion marked by annular striations. Width of head, exclusive of inflation, about 16μ. Cuticle of body inflated and marked by longitudinal striae, each striation showing cross striations. Esophagus 275 to 300μ long and 20 to 25μ wide in its distal portion. Nerve ring about 150 to 175μ, and excretory pore about 20 to 27μ, anterior to termination of esophagus

Male about 4 to 4.5 mm. long by 45 to 50μ wide just anterior to bursa. Cuticular inflation extending on ventral side of body to within 30 to 35μ anterior to commencement of bursa Bursa symmetrical, with 2 lateral lobes and 1 dorsal lobe. Spicules 350 to 375μ long, filiform, distal ends divided into 2 branches enclosed in a sheath Gubernaculum absent. Ventro-ventral ray shortest and slenderest of the paired rays, directed forward and widely separated from latero-ventral ray. Latero-ventral, externo-lateral and medio-lateral rays of about equal thickness and length, the first 2 being parallel and diverging only slightly in their distal portions, externo-lateral the thickest ray; medio-lateral ray the longest ray and directed straight towards margin of bursa. Postero-lateral ray originating from a common stem with medio-lateral and directed dorsally; these two rays widely separated at their tips. Externo-dorsal rays and dorsal ray originating from a common stem, the former being very slender and curving outward from dorsal; stem of dorsal very wide and bifurcating at middle; each branch divided at tip, outer branch longer than inner. None of rays reaching margin of bursa.

Females 5 to 5 5 mm long and about 90μ wide in region of vulva. Single ovejector, including sphincter, about 100μ long by 40μ wide Vulva about 100μ from anus; anus about 30μ from tip of tail; tip of tail narrowing abruptly about 5μ from end and terminating in a conical, blunt point. Eggs 60 to 65μ long by 30 to 35μ wide.

Host.—Rattus sp.

Location.—Small intestine.

Locality.— Jeanerette, Louisiana, U S. A.

Type specimens.—U. S. National Museum Helminthological Collection No. 30457

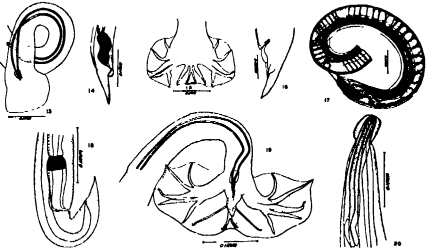
The nematode here described under the name of *Longistriata norvegica* is very similar to the nematode described by Chandler (2) as *Longistriata adunca* from the cotton rat, *Sigmodon hispidus*. Chandler, however, described an accessory piece or gubernaculum as being present in the nematode described by him. No such structure has been observed in the nematode described here as *Longistriata norvegica*. The writer, therefore, must accept Chandler's description as correct, pending some reexamination of his material or a comparative study of these two nematodes.

Longstriata carolinensis, n. sp. Figs. 13–17.

Specific diagnosis —Longistriata: Worms small, usually rolled in a loose spiral. Cervical inflation about 50μ long by 30μ wide. Cuticle of body inflated and marked with distinct longitudinal striations or bands, these in turn distinctly marked with cross-striations. Head rounded, mouth opening and circumoral papillae inconspicuous. Esophagus 280 to 310μ long by 35 to

40μ wide in its terminal portion. Excretory pore about 120μ anterior to termination of esophagus. Nerve ring slightly anterior to excretory pore.

Male 2.7 to 3 mm long and 70 to 80μ in maximum diameter immediately anterior to bursa. Bursa symmetrical, 125 to 130μ long and 225 to 250μ wide when fully expanded. Ventro-ventral rays short and slender, directed forward; latero-ventral ray widely separated from and somewhat larger than ventro-ventral ray and also directed forward; externo-lateral, thickest of the paired rays, widely separated from latero-ventral, but parallel to medio-lateral except at tip, here the latter two rays diverging slightly, externo-lateral bending ventrad and medio-lateral running straight toward margin of bursa; postero-lateral ray originating from medio-lateral ray and directed posteriorly to margin of bursa, the tips of these rays widely separated, all these rays reaching margin of bursa Externo-dorsal rays originating separately from dorsal ray; dorsal ray divided into rather long branches, each of these bifurcated at tip; branches of bifurcation equal in size Spicules 400 to 450μ long, filiform, with expanded proximal ends Gubernaculum about 25μ long by 15μ wide.



Figs 13-17 —*Longistriata carolinensis* Fig 13 Posterior portion of male, showing spicules and gubernaculum Fig. 14 Posterior portion of female, showing ovejector Fig 15 Bursa Fig 16 Posterior portion of female, showing relative positions of vulva and anus Fig 17 Posterior portion of female

Figs 18-20 —*Longistriata dalrymplei*. Fig 18. Posterior portion of female, showing ovejector. Fig. 19. Posterior portion of male, showing bursa and spicules. Fig 20 Anterior portion showing cuticular inflation

Female about 3.5 mm. long. Ovejector single, about 80μ long. Vulva 60 to 65μ from anus; tip of tail 40 to 50μ from anus. Tail narrowing abruptly shortly before its termination and ending in a blunt point. Eggs 58μ long by 30 to 35μ wide.

Hosts.—*Peromyscus maniculatus* (Deer mouse), and *Microtus ochrogaster* (Prairie meadow mouse).

Location.—Small intestine.

Localities.—Great Smoky Mountains, North Carolina, and Vincennes, Indiana, U. S A.

Type specimen—U. S. National Museum Helminthological Collection No. 30458.

Longistriata dalrymplei, n. sp. Figs. 18–20.

Specific diagnosis.—*Longistriata.* Worms small, delicate, usually rolled in a loose spiral. Cervical inflation 45 to 60μ long by 27 to 43μ wide. Cuticular inflation with prominent longitudinal lines marked with cross-striations Esophagus about 250 to 300μ long and 20 to 25μ wide in its terminal portion. Position of nerve ring and excretory pore not determined owing to condition of specimens

Male 3.7 to 4 mm. long and 40 to 50μ wide in maximum diameter. Bursa symmetrical, about 125μ long and 300μ wide when fully expanded. Ventro-ventral ray directed forward and widely separated from latero-ventral ray at the tip; latero-ventral ray slender and pointed, directed ventrad and extending to margin of bursa, externo-lateral thickest of bursal rays, directed toward lateral margin of bursa, but bending slightly forward before reaching margin. Medio-lateral ray straight and directed toward margin of bursa; postero-lateral ray originating from medio-lateral ray and directed dorsad, tips of two latter rays far apart Externo-dorsal ray slender, originating from dorsal ray 30μ from its base; dorsal ray about 75μ long, dividing into 2 branches about 20μ from distal end, each branch bifurcating at the tip; outer secondary branch longer than inner branch Spicules straight, filiform, 340 to 360μ long Gubernaculum small, almost colorless, about 25 to 30μ long by 15μ wide Genital cone well developed and prominent

Female 4 to 4 7 mm long, and 70 to 80μ in maximum diameter in region of ovejector. Ovejector single, well developed, about 100μ long. Vulva to anus, 50 to 60μ; anus to tip of tail, 40 to 60μ Tail ending in a sharp point. Eggs 55 to 65μ long and 35 to 40μ wide

This nematode closely resembles *Longistriata vexillata* (Syn. *Heligmosomum vexillatum* Hall, 1916). It differs from the latter in the possession of a gubernaculum, in the absence of spurs on the dorsal ray between the origin of the externo-dorsal rays and the bifurcation, and in the absence of maculae on the bursal membrane

Hosts.—*Ondatra zibethica* (Muskrat) and *Microtus pennsylvanicus* (Meadow mouse)

Location—Small intestine.

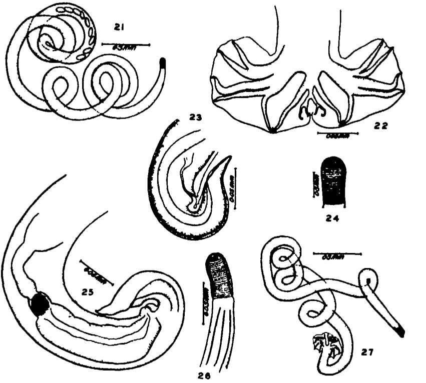
Localities—New Jersey, Indiana, and Minnesota, U. S A

Type specimens—U. S National Museum Helminthological Collection No. 30459

Longistriata noviberiae, n. sp. Figs 21–27.

Specific diagnosis—*Longistriata* Worms small, delicate, spirally coiled, bright red in color when freshly collected Cephalic cuticle slightly inflated, showing distinct transverse striations; inflation 45 to 60μ long by 25 to 30μ wide Cuticle of body inflated, showing longitudinal striae marked with cross-striations. Esophagus 270 to 300μ long by 25 to 32μ wide near its termination Nerve ring 165 to 175μ from anterior end. Excretory pore situated from 15μ anterior to 25μ posterior to termination of esophagus.

Male 4 to 5 mm. long by 55 to 65μ in maximum diameter. Bursa symmetrical, about 130 to 150μ long and 240 to 260μ wide when expanded. Ventral rays of approximately the same size, divergent at tips and directed forward, reaching margin of bursa, latero-ventral ray terminating in a slight projection on bursal margin; externo-lateral and medio-lateral rays close together and parallel for greater part of their length, diverging near



Figs 21–27.—*Longistriata noviberiae* Fig 21 Female Fig 22 Bursa. Fig 23. Terminal portion of female Figs 24 and 26 Anterior portion of body, showing cervical inflation Fig 25 Posterior portion of female, showing ovejector Fig 27 Male

their termination; externo-lateral ray bending sharply ventrad, and medio-lateral ray continuing straight to bursal margin; postero-lateral ray originating from medio-lateral ray, diverging sharply from latter, and directed dorsad, reaching posterior margin of bursa, tips of these two rays widely separated; externo-dorsals originating from a common stem with the dorsal ray and approaching posterior margin of bursa in close proximity to termination of postero-lateral rays; dorsal ray bifurcated, forming 2 fairly widely divergent branches, the latter also bifurcating to form 2 terminal branches. Bursal margin slightly indented in region of dorsal ray Spicules slender, filiform and equal, 420 to 430μ long Gubernaculum present, about 35μ long by 15μ wide.

Female 5.5 to 6 5 mm. long by 75 to 80μ wide in region of vulva. Tail pointed and bent sharply ventrad in all specimens examined. Vulva with 2

prominent lips, about 100 to 120μ from tip of tail; anus 45 to 55μ from tip of tail. Ovejector single, about 165μ long. Eggs 70 to 75μ long by 35 to 40μ wide.

Host.—Rabbits (probably *Sylvilagus floridanus alacer* and *Sylvilagus palustris littoralis*).

Location.—Small intestine

Locality.—Jeanerette, Louisiana, U. S. A.

Type specimens—U S National Museum Helminthological Collection No 30460.

THE GENUS LONGISTRIATA

In their key to the genera of the family Heligmosomidae, Yorke and Maplestone (1926), regard the spiral rolling of the body as a generic character, and on the basis of that character they separate the genera *Heligmosomum* and *Viannaia*. The acceptance of this feature as a character of generic value has led to confusion and has resulted in the inclusion in the genus *Viannaia* of nematodes which obviously do not belong to it. Schulz (4) proposed, therefore, the subgenus *Longistriata* in the genus *Viannaia* to include those nematodes in which the body is spirally rolled as in *Viannaia*, and in which there are comparatively long spicules and a cuticle distinctly marked with longitudinal striations as in *Heligmosomum*. Travassos and Darriba (6), after noting that the spiral rolling of the body cannot be considered as a distinguishing character, raised Schulz's subgenus *Longistriata* to the status of a genus, with *Longistriata depressa* (=*Strongylus depressus* Dujardin, 1845) as type, transferred several nematodes placed by Travassos (1921) in the genus *Heligmosomum* to the genus *Longistriata*, and made the genus *Heligmonella* Monnig, 1927, a synonym of the genus *Viannella* Travassos, 1918.

The genus *Heligmonella* was created by Monnig (3) with the following diagnosis: "Heligmosominae: body red, spirally coiled, cuticle with marked longitudinal striations; cephalic cuticle inflated and transversely striated Male: bursa with ventral rays separate and diverging, postero-lateral diverging from externo- and medio-lateral, externo-dorsal arises from a common dorsal trunk, dorsal bifurcated near its extremity, the branches also bifurcated; spicules slender, gubernaculum distinct. Female: vulva near anus, a single uterus. Parasites in stomach and intestine of rodents."

The genus *Heligmonella* differs, therefore, markedly from the genus *Viannaia* in the character of the spicules and in the course and direction of the bursal rays, and its proposed inclusion in the genus *Viannaia* appears to be unwarranted. The genera *Longistriata* and *Heligmonella* resemble each other in the possession of (1) transversely striated cephalic inflation, (2) an expanded and longitudinally striated cuticle, (3) comparatively long and slender spicules, and (4) comparably directed bursal rays, and on the basis of these resemblances the genus *Heligmonella* is here made a synonym of the genus *Longistriata*.

Baylis (1) described a number of new species in the genus *Heligmonella*. These species also are here transferred to the genus *Longistriata*.

It is recognized that the nematodes described in this paper as *Longistriata musculi*, *L. norvegica* and *L. carolinensis*, while resembling other members of the genus *Longistriata* in the possession of an inflated and transversely striated cephalic cuticle, an expanded and longitudinally striated body cuticle, and long and slender spicules, differ from each other and from other members of this genus in the character and direction of the bursal rays, and that their inclusion in this genus may seem to be unwarranted. However, since only a limited amount of material was available for study it was not considered desirable to create new genera for them at the present time.

Heligmostrongylus hassalli Price, 1928, also is here placed in the genus *Longistriata* because in all other species of the genus *Heligmostrongylus* the dorsal ray is completely doubled and in *Heligmostrongylus hassalli* this feature is absent.

The generic diagnosis is amended as follows:

LONGISTRIATA

Generic diagnosis.—Heligmosomidae: Body more or less strongly rolled in a spiral. Cephalic cuticle inflated, marked with annular striations. Cuticle of body expanded and distinctly marked with transversely striated longitudinal lines, continuous or interrupted at intervals. Bursa symmetrical or asymmetrical, with well developed single bifurcated dorsal ray Spicules comparatively long and slender. Gubernaculum present or absent. Female with well developed single ovejector close to posterior end of body. Vagina short. Vulva close to anus.

Type species.—*Longistriata depressa* (Duj., 1845).

KEY TO SPECIES OF LONGISTRIATA

1.	Gubernaculum present and well developed	2
	Gubernaculum absent or rudimentary.	16
2.	Longitudinal striae interrupted at regular intervals	*L. hassalli*
	Longitudinal striae continuous	3
3.	Gubernaculum asymmetrical.	*L. seurati*
	Gubernaculum symmetrical	. 4
4.	Spicules 1 mm. long.	*L. minnigi*
	Spicules varying in length from 230 to 450μ	5
5.	Dorsal margin of bursa deeply indented.	*L. cristata*
	Dorsal margin of bursa only slightly indented or without indentation	6
6.	Externo-dorsal rays originating separately from dorsal ray. .	*L. carolinensis*
	Externo-dorsal rays originating from a common stem with the dorsal ray	7
7.	Bursa asymmetrical.	8
	Bursa symmetrical.	9

8. Bursa large, 500 to 600μ wide; branches of dorsal ray close together and each provided with 2 terminations. *L. streptocerca*
   Bursa about 250μ wide; branches of dorsal ray fairly wide apart and each provided with 3 terminations. *L. trifurcata*
9. Branches of dorsal ray as long as or longer than main stem. *L. intermedia*
   Branches of dorsal ray shorter than main stem. 10
10. Externo-dorsal rays very slender. *L. dalyrmplei*
   Externo-dorsal rays comparatively stout. 11
11. Terminal branches of dorsal ray equal. *L. wolgaense*
   Terminal branches of dorsal ray unequal. 12
12 Males 2 6 to 3 25 mm. long, females 3.4 to 3 9 mm. long. 13
   Males 3.8 to 5.5 mm long; females 5.5 to 9.2 mm. long. 14
13. Spicules 400μ long by 4 to 5μ wide; vulva 120μ from tail end. *L. affinis*
   Spicules 230 to 280μ long by 2.5μ wide, vulva 150μ from tail end.. *L. gracilis*
14. Spicules 270 to 360μ long; vulva 150μ from tail end. *L. impudica*
   Spicules 410 to 430μ long; vulva either 120μ or 165μ from tail end. 15
15 Spicules 410μ long; vulva 165μ from tail end; ovejector 310μ long. *L. spira*
   Spicules 420 to 430μ long; vulva 120μ from tail end; ovejector 165μ long. *L. noviberiae*
16. Dorsal ray with accessory branch. *L. vexillata*
   Dorsal ray without accessory branch. .17
17. Stem of dorsal ray 20μ wide. . *L. norvegica*
   Stem of dorsal ray 5 to 15μ wide 18
18. Externo-dorsal rays largest of bursal rays; distal ends of spicules enlarged. *L musculi*
   Externo-dorsal rays larger than some and smaller than other bursal rays; distal ends of spicule not enlarged. 19
19. Spicules 600 to 800μ long. .20
   Spicules 340 to 560μ long. .22
20. Dorsal ray doubled for more than half its length. *L. nematodiriforme*
   Dorsal ray divided into 2 branches, each less than half the length of dorsal ray. 21
21 Externo-dorsal ray very slender; inner branch of terminal bifurcation of dorsal ray with slight projection. *L. didelphe*
   Externo-dorsal ray stout; inner branch of terminal bifurcation of dorsal ray without projection. *L. alpha*
22. Terminal branches of dorsal ray not divided. *L. gamma*
   Terminal branches of dorsal ray divided. 23
23. Terminal branches of dorsal ray equal. *L. delta*
   Terminal branches of dorsal ray unequal, outer branch longer. *L. beta*

Longistriata adunca Chandler, 1932, is similar to *L. norvegica*, differing only in the presence of a gubernaculum described for *L. adunca*.

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BOTANY.— *Certain Desmonci (Palmae) of Central America and Mexico,*[1] H. H. BARTLETT, University of Michigan.[2]

The genus *Desmoncus* provides one of the characteristic features of tropical American vegetation. It is often remarked that in the western hemisphere the *Desmonci* take the place of the far more viciously armed climbing palms of the Oriental tropics, such as *Calamus* and *Daemonorops,* which are systematically not closely related, but in their climbing habit, armature, and ecological relations offer some points of resemblance.

To secure specimens of the climbing palms takes much of a collector's time and effort, since they are often not found in fertile condition or easily secured even if found, because of their spininess and difficulty of disengaging them from the limbs of the trees through which they clamber. Good specimens are therefore disproportionately rare in our herbaria, in consideration of their importance in the composition of the tropical forest. Many of the described species are inadequately known, and it has become customary to use a few names as catch-alls for very distinct plants.

It appears that the species of *Desmoncus* are in reality rather local in distribution, and that much careful work on the part of collectors and herbarium botanists will be required to ascertain their ranges and characteristics.

In British Honduras and Guatemala the writer came in contact with a group of *Desmonci* related to *D. chinantlensis* Liebm., which

[1] Received November 20, 1934.

[2] Papers from the Department of Botany and the Herbarium of the University of Michigan, no. 508.

was described from Mexico and remains very inadequately known. These related plants of northern Central America are called "basket tie-tie" or "basket whist" by the inhabitants of British Honduras and "bayal" by the Spanish-speaking people and the Maya. In British Honduras any vine is a "tie-tie," and the *Desmonci* are the particular "tie-ties" of which baskets are made —whence the name.

Either there are many local species with rather slight distinctions, as the writer believes, or else there is a very wide-spread species, *Desmoncus chinantlensis* Liebm., made up of a group of varieties, or (as some botanists might even conclude) of taxonomically negligible variations. Several of these minor species are here described. There are indications in the herbaria that other species of the same order of distinctness remain to be described, but unfortunately entirely satisfactory material is lacking.

In addition to the species related to *D. chinantlensis* there are others farther south in Central America which have quite different relationships. It is evident that the alliance of *D. chinantlensis* does not hold the field alone much south of Guatemala, although Bailey[3] found a species in Panama which he has tentatively referred to it.

There is some question as to the interpretation of Liebmann's *D. chinantlensis* which might best be cleared up by renewed collecting and study at the type locality. Bailey refers to a sheet at Copenhagen as the type specimen (Liebmann no. 6595), and remarks that it does not agree with two specimens in the United States National Herbarium (Liebmann nos. 6594 and 6596). Since the original description (Martius, Historia Palmarum **3**: 321. 1850) cites no specimen whatever, it seems best to typify the species by a specimen or specimens conforming as closely as possible with the original description, and from this standpoint the specimens in the United States National Herbarium may be fairly viewed as cotypes. I have considered them as such in my interpretation of the species. The justification for so doing lies in the fact that the *Desmoncus* from Barro Colorado Island, Panama, which Bailey figures and which agrees with the particular Liebmann specimen (no. 6595) that he regards as the type of *D. chinantlensis*, does not conform to the original description. It appears to lack the beard of spines on the upper side of the base of the leaflet, which is characteristic of the entire alliance of *D. chinantlensis*, and which Liebmann refers to in the description ("*pinnis . . . antice juxta nervum aculeatis*"). Bailey's Barro Colorado plant also agrees with Liebmann's no. 6595 in having "thin, not stiffly veined glabrous pin-

[3] BAILEY, L. H. *Certain palms of Panama.* Gentes Herbarum **3**: 31–116. 1933

nae 8 inches or less long." On the contrary, the two Liebmann specimens in the National Herbarium have, as Bailey says, "different looking, very costate pinnae and much smaller spines." Referring again to Liebmann's original description, we find that the lower leaflets should be 9 inches long, not 8 *or less*, and that the pinnae should be strongly plicate ("*pinnis . . . valde plicatis*") rather than "thin, not stiffly veined." Furthermore, Liebmann describes a type with dimorphic spines on the petioles and lower rhachis, and with the leaflets irregularly aggregated, whereas Bailey's species, which agrees with Liebmann 6595, has (according to the figure) spines of a single type and pinnae "mostly opposite or subopposite." In view of the discrepancies between Bailey's plant and the Liebmann description of *D. chinantlensis*, I have preferred to interpret the latter as being really represented by Liebmann's nos. 6594 and 6596 in the United States National Herbarium.

The entire alliance of *Desmoncus chinantlensis* lacks hooked prickles, has a beard of *aciculae* on the upper surface of the leaflet near the base, and is presumably characterized by nine rather than six stamens, although not all of the species are known from flowering specimens. Leaving out a couple of species which are doubtless distinct, but of which the material is inadequate for description, the group may be arranged as follows:

Corolla of female flower containing at one side of the ovary a fimbriate, oblong, basally attached scale as long as the corolla lobes; leaflets only about 1 cm. broad. *D. anomalus*

Corolla of female flower containing no such scale; leaflets over 2.5 cm. broad.

Axis and branches of inflorescence thick and somewhat fleshy . . . *D. chinantlensis*

Axis and branches of inflorescence thin, not fleshy

Rhachis even if short-aciculate also armed below the middle with a few distant retrorse or subretrorse spines which are the longest ones on the plant.

Inferior spathe aciculate: female flowers with annuliform-cupulate calyx, very obtusely 3-apiculate and corolla broader than high, nearly evenly truncate, but sharply though minutely 3-apiculate. *D. Lundellii*

Inferior spathe entirely or nearly unarmed: female flowers with acutely triangular-cupulate calyx and corolla higher than broad with margin 3-apiculate from deep rounded sinuses. . *D. quasillarius*

Rhachis sparsely to densely aciculate with spines no longer than those on other parts of the plant, and not clearly dimorphic.

Inferior spathe almost unarmed... ... ..*D. uaxactunensis*
Inferior spathe aciculate: corolla of female flower broader than high, obtusely 3-apiculate with shallow obtuse sinuses.....*D. ferox*

Desmoncus anomalus sp. nov.

Scandens pergracilis. Vaginae pars superior (ochrea) 12 mm. diam., 22 cm. longa albida, cinnamomeo-furfuracea, subappresse aciculata, aciculis majoribus 8 mm. longis, juventate ferrugineo-pubescentibus. Petiolus 1.5 cm longus, debiliter et breviter aciculosus. Rhachis petiolo similis 165 cm. longa subtus subinermis, furfuracea, supra sparsim armata, aciculis majoribus 12 mm. longis. Foliola utrinque ca. 19, basi debiliter aciculata inferiora ca 22 cm longa, 7 mm. lata in filum attenuata; mediocria ca. 21 cm. longa, 10–12 mm. lata; superiora 24 cm. longa, 8 mm. lata, caudato-acuminata. Foliolorum paria intermedia in uncos transeuntia reflexa, ca. 14 cm longa, 2 mm lata Uncorum paria 10 debilia, inferiora ca. 12 cm. inter se distantia, 6 cm longa, superiora 1.5 cm distantia, 2.5 cm. longa. Cirrhus omnino inermis Spatha inferior 28 cm longa, 14 mm. lata, sparsissime breviterque appresso-aciculata. Rami fertilis pars inter spathas 29 cm. longa, 10 mm. lata, compressa, sparsim appresso-aciculata Spatha superior deest. Pedunculus 6 cm. longus, aciculas 4–10 mm longas ferens. Rhachis ramifer 20 cm. longa, albida, sparse ferrugineo-furfuracea, ramis floriferis ca 35 valde flexuosis, inferioribus 12 cm longis Flores inferiores terni, bracteolis 1 vel 3 firmis brevissimis anguste lunulatis vel canaliculiformibus apiculatis subtenti Flores feminei centrales, gamopetali et gamosephali. Calyx subannuliformis vel circumscriptione rotundato-triangulus, angulis obtusissimis rotundatis Corolla (solum vetusta fructibus delapsis visa) obtusissime apiculata, unilateraliter includens squamam lobis corollae 2.2 mm longis propriis aequilongam et 2 mm. latam apice fimbriatam. Staminodia vestigialia basi corollae connata. Pistillum et fructus desunt. Flores masculi omnes delapsi sed eorum cicatrices in ternis inferioribus laterales et in ramorum apicibus singuli.

Specimen typicum in U. S. Nat Herb in Guatemala legerunt *O. F. Cook* et *C. B Doyle*, no 97, ad Secanquim, in Alta Vera Paz.

Desmoncus Lundellii sp. nov.

Scandens caule sursum vaginis tecto 2.5 cm. diam. nudato ca 1.7 cm. Folia caulem imbricate vaginantia. Vaginae supra petioli insertionem in ochream apice in fibros dissolutam 18 cm. longam productae, pallide griseo-cinnamomeae, aciculis ex papillis anguste conicis vel subcylindricis orientibus, subascendentibus atris juventate sordide furfuraceo-pubescentibus, longioribus 16 mm longis dense armatae Petioli pars libera 2 cm. longa 12 mm. lata et rhachis pars basalis subtus sparsim supra densius aciculatis cum duarum aciculis specierum aut pergracilibus ca. 6 mm. longis aut validis 3 5-5 cm longis. Rhachis ca 1.75 m. longa foliolis utrinsecus ca. 20, lanceolatis, acutis, gregatim alternis, infimis ca. 17 cm. longis 2.5 cm latis; mediis ca. 32 longis 3.4 cm. latis; supremis 26 cm longis, 3.0 cm. latis; transitionalibus retroflexis 1-jugis 14 cm longis 4 5 mm. latis; amnibus longitudinaliter subplicatis ca. 20-venosis utrinque obscure transverse venulosis, supra prope basin horride aciculatis, aciculis ca. 20–30, longioribus 3 0–4.0 cm. longis, subascendentibus, etiamque in venae mediae tertia parte basali aciculas 2–4 ferentibus Cirrhus sparsim longiaciculatus uncos jugatim ferens, basi valde incrassatos, lateraliter compressos, rigidos,

majores 3.5 cm. longos, secus rhachin 11 cm. separatos; intermedios 2.5 cm. longos, 7 cm. separatos; ultimos non visos. Spatha inferior fere glabra apice sparse et appresse breviaciculata. Spatha superior fusiformis 22–30 cm. longa, 3–4 cm. diametiens, dense armata, aciculis atris rectis diverse directis majoribus ca 12 mm longis. Pedunculus 4–10 cm longus aciculis subascendentibus vestitus Inflorescentiae pars ramosa 18–20 cm longa, solum ad basin aciculata ramis simplicibus ca 30, longioribus 10 cm. longis, hand carnosis valde acutangulatim contortis vel flexuosis. Flores superiores solitarii staminei sessiles bracteolis rigidiusculis subretroflexis .5–1.0 mm. longis subtenti, ex calyce membranaceo gamosepalo, corolla longe pyramidato tripetala et staminibus (9?) constituti, calyce excentrico, horizontaliter 3 3 mm lato (si applanato), longitudinaliter 2 3 mm. diametiente; petalis carnosis, deltoideis 9 mm. longis, longe acutis Flores inferiores terni unus femineus medius alii 2 staminei (delapsi) lateraliter et superiuscule positi et bracteolis minutis triangulis subtenti Floris feminei calyx symmetricus membranaceus 3 mm diam annuliformis apices subobsoletos sepalorum unitorum obtusissimos obscure exhibitantes Corolla carnosa sympetala cyathiformis 2 8 mm diam 2 5 mm alta, margine minutissime triapiculata Stamina vel staminodia nulla Ovarium uniloculariurn ellipsoideum apice acuto breviter 3-stigmatosum Fructus ovoideus 13 mm. longus, 11 mm diametiens, pericarpio tenui carnoso, endocarpio osseo paululum supra aequatorem foraminibus 3, placentis parietalibus oppositis, perforatis.

Specimen typicum in Herb. Mich legit *C L. Lundell* prope El Paso de Petén, Petén, Guatemala, 26 Apr 1932.

Desmoncus quasillarius sp nov

Scandens, caule vaginato ca 3 cm crasso Vaginae pars supra petioli insertionem (ochrea) ca. 15 cm longa, apice in fibros dissoluta, griseo-cinnamomea, aciculis atratis plerumque quam 1 cm brevioribus modice tecta. Petiolus 22 mm longus minus aciculatus quam ochrea Rhachis ca 1 9–2 0 m longa, tenuiter ferrugineo-furfuracea, supra aciculas specierum duarum ferens, paucas compressas fere 14 mm longas et alias breviores, omnes patentes vel subascendentes; subtus solum infra medium spinas longiores pauciores retroflexas 2 cm longas validas ferens, sursum in cirrhum omnino inermem transeuns Foliola subplicata, glabra, utrinsecus ca. 22, inferiora irregulariter aggregata, superiora pariter subalterna vel subopposita; infima 23 cm longa, 14 mm. lata, supra ad basin barbatim aciculata, aciculis ca 6–10 longioribus 15 mm longis, apice longe attenuata, et subtus, caudam apicalem versus, acicula solitaria 13 mm. longa instructa; media ca 30 cm. longa, 3 cm. lata acuminata ad basin minus barbata, solum 4–6 aciculas, longiores ca 20 mm longas, ferentia; suprema 24 cm longa, 32 mm lata, basi et apice longe angustata, leviter barbata, aciculas solum 1–3 breves ferentia Foliola 2 transeuntia in uncos recurvata base incrassata non barbata 18.5 cm longa 18 mm lata Uncorum paria 9 infima 7 cm. longa, inter se 10 cm. distantia, sequentia gradatim breviora et propinquantia. Spatha inferior inermis vel sparsissime et breviter aciculata, ca. 14–18 mm. lata; pars aperta ca. 7 cm. longa Ramus fertilis infra spatham superiorem sparse et breviter aciculatus. Spatha superior fusiformis ca 27 cm. longa, 22 mm. crassa, deorsum angusta ferrugineo-furfuracea, breviter (2–4 mm) aciculata, sursum horride aciculata, aciculis diverse directis plerumque porrectis. Pedunculus 5 cm. longus, patenter et breviter aciculatus, aciculis longioribus ca. 4 mm. longis, haud retrosis. Inflor-

escentiae axis simpliciter ramifer inermis, tenuiter ferruginosus, ramis valde angulatim flexuosis ca. 35, deorsum flores ternatim sursum singulatim ferentibus, gracilibus, haud carnosis Flos centralis femineus, laterales staminei, omnes bracteola subcartilaginea communi probabiliter composita, anguste lunata, obscure 3-apiculata vel integra, subtenti Flores feminei conici vel subcylindrici, gamosepali, gamopetali; calyce cupuliformi 2 5 mm. diam. (si non applanato) 1 mm. alto, margine minute et distanter triapiculato; corolla 3 5 mm. alta, 2.3 mm. lata, apice profunde (tertia parte) tricuspidata, apicibus triangulo-subulatis, sinubus rotundatis; staminodiis vestigialibus minutissimis; ovario corollam excedente, anguste ablongo, breviter tristigmatoso Flores masculi in parte rami floriferi terminali singuli, bracteolis singulis vel binis brevibus acutis divergentibus subtenti. Flores staminei 10–12 mm. longi, calyce membranaceo gamosepalo cupuliformi acute triapiculato, si applanato asymmetrice triangulo, angulis acutis Petala 3 distincta cartilaginea basi subovata apice sublutao longe producta. Stamina 9 Pistillodium nullum.

Specimen typicum fructiferum in Herb Mich legit *Percy Gentle*, no 348, in Dist Corozal, British Honduras, et specimina alia florentia prope San Andres, Corozal, British Honduras, no 4750, et fructifera, no 528

D quasillarius is the "basket tie-tie" or "basket whist" of northern British Honduras

Desmoncus uaxactunensis sp. nov.

Scandens maturitate 5–15 m altus, caule vaginis tecto ca. 4-5 cm crasso, nudato 2–3 cm crasso. Folia caulem imbricate vaginantia Vaginae sursum in ochream ca 30 cm longam, griseo-cinnamomeam furfuraceo-pubescentem, apice demum in fibros disolutam dense aciculis tenuibus atratis subascendentibus 4–18 mm longis praeditam productae Aciculae juventate fur-furaceae demum nitidae rectae ex papillis bulbiformibus orientes Petioli para libera ca 9-12 mm. lata 2 cm longa et rhachis pars inferior colore vaginae similes furfuraceo-pubescentes aciculis quam eis vaginae brevioribus postice subsparsis antice densius positis obtectae Rhachis ca 2 25 m longa, foliolis utrinsecus ca. 25, infimis 25 cm. longis 2 cm. latis; medus ca 30 cm. longis 4 cm latis; supremis ca 35 cm longis 4 cm latis, omnibus utrinque concoloribus vel subtus pallidiusculis, proper margines vel glabratis vel evanescenter furfuraceo-pubescentibus, obscure subplicatis, basi angustatis replicatis apice acuminatis, ven media sola prominenti venis alus longitudinalibusa equaliter evidentis supra cum venulis obliquis transversis subtus absque venulis transversis, supra prope basin aciculos ca. 10 graciles atratos 2 cm longos vel breviores barbatim ferentibus etiamque 2 vel 3 alios in nervo medio infra mediam folii partem Foliola irregulariter alternantia abrupte per solum 2 intermedia 18 cm. longa 18 mm lata exacte foliacea sed retrorsa transeuntia in uncos 9-jugos subrigidos lateraliter compressos et applanatos non foliaceos, infimos 6 cm. longos, 15 cm secus rhachin separatos, supremos 1–2 cm longos, 1 cm separatos. Cirrhus in extremitate solum modo uncis armatus, deorsum sparsissime spinis gracilibus 2 cm longis armatus vel subinermis. Ramus fertilis infra spathas semicylindricus 10–13 mm. latus 35–40 cm longus brunneo-lepidotus omnino in vagina occultus Spatha inferior etiam semicylindrica, ca 20 mm. lata, 40 cm. longa, facie plana interiore glabra, pallida, dense longitudinaliter venosa, facie concava tenuiter brunneo-lepidota, apice aperto angustata exfimbriata. Spatha superior fusiformis 28 mm longa 4 cm. crassa furfuraceo-pubescens et dense

spinis atratis vario aggregatis in tuberculos sedentibus valde flexuosis vel rectis armata. Inflorescentia spatham superiorem non excedens Pedunculi pars libera 5 cm longa, 5 mm. crassa, lepidoto-furfuracea spinis 3–5 mm. longis tenuissimis ascendentibus tecta Axis in parte inflorescentiae ramosa inermis, furfuraceus, 20 cm. longus, ramulos 40–50 floriferos simplices 4–12 cm. longos valde acute angulatim flexuosos ferens Flores ad ramuli basin ternatim aggregati, ferior et centralis fertilis, staminei bini laterales. Fructus maturus ovoideus 15 mm. longus 12.5 mm diametiens, minute apiculatus.

Specimen typicum in Herb. Univ. Mich. conservatum legit *H H. Bartlett* in vicinitate oppidi Uaxactun Mayarum antiquorum, Petén, Guatemala, 18 Apr. 1931, no. 12576.

Desmoncus uaxactunensis differs from the closely related *D. chinantlensis* Liebm. most obviously in the much more slender and more sharply zigzagged branches of the fruiting inflorescence. Under a lens the prophyllum subtending the flower groups is seen to have a sharply triangular retrorse tip which is lacking in *D. chinantlensis*. The beard of slender spines on the base of the top of the lamina consists of a larger group of more closely placed spines. Doubtless other distinctions of flowers and fruit would be obvious if more complete material of *D. chinantlensis* were available for comparison.

Desmoncus ferox sp. nov.

Scandens gracilis, 2 cm. crassus, caule vaginis obtecto Pars vaginae superior (ochrea) 25 cm longa, apice demum in fibris dissoluta, sordide albida ferrugineo-furfuracea et dense armata, spiculis ca 12–22 mm longis, atris, gracilibus, juventate derosum pubescentibus, basi ex tuberculis cylindricis orientibus Petioli pars libera 2–3 cm longa Rhachis tenuiter ferrugineo-pubescens supra aciculis interdum 20 28 mm longis armata subtus subinermis vel spiculis multum brevioribus praedita, ca 2 5 m longa, utrinque usque ad cirrhum (ca 1 m longum) foliolos ca 24 ferens Foliola inferiora ca 30 cm longa, 1 5 cm lata longe attenuata in caudam filiformem 8 cm longa; intermedia ca 29 cm longa 1 cm lata, apice solum acuminata non filiformi-caudata; superiora ca 36 cm longa, 46 mm lata acuminata sed sub lente bifida vel praemorsa; omnia longitudinaliter subplicata et venosa, utrinque sub lente tenuissime minutissimeque atropubescentia et transverse venulosa, subtus inermia, supra prope basin direciter multiaciculata, aciculis longitudine eis vaginae rhachisque similibus interdum 30 mm. longis, utrinque acicula sola brevi (ca 8 mm longa) in vena media infra folioli medium instructa. Foliola in uncos transeuntia solum 2 subopposita, foliacea, 27 cm longa, 12 mm lata, basi uncis similiter tumida et reflexa Uncorum paria 10, rigida, lateraliter compressa, inferiora 9 cm. longa 26 cm. inter se distantia, intermedia 4 5 cm longa, 7 cm. distantia Spatha inferior 22 mm lata, pars clausa plus quam 21 cm longa, pars aperta 13 cm longa, sursum ferrugineo-furfuracea et mediocriter aciculata, aciculis de causa compressionis in vagina plerisque appressis sed prope orificium patentibus 7 mm. longis. Ramus fertilis infra spatham superiorem 11 mm crassus, appresse et breviter aciculatus, ferrugineus Spatha superior fusiformis, ca 40 cm longa, 3 cm diametiens, cinnamomeo-albida et ferrugineo-furfuracea, apice breviter filiformi-caudata, deorsum appresse et breviter aciculata sursum valde horride patenter aciculata, aciculis

atratis, diverse directis, longioribus 18 mm. longis. Pedunculus ca. 7 cm. longus deorsum inermis sursum aciculatus, aciculis majoribus 13 mm. longis. Axis inflorescentiae pars ramosa ca 24 cm. longa, inermis, albida et tenuiter ferrugineo-pubescens, ramos ca. 40 inferiores 15 cm. superiores 6 cm longos simplices floriferos ferens, ramis (siccis) angulatis, valde angulatim flexuosis, deorsum flores sessiles ternatim sursum singulatim ferentibus. Flores feminei centrales inter 2 masculos siti depresso-globosi 3 mm. lati 2.5 mm. alti gamosepali gamopetali. Calyx subrotundus annulatus breviter margine 3-apiculatus symmetricus 3 3 mm. diam Corolla cyathiformis margine constricta ovarium includens sessile breviter 3-stigmatosum Staminodia nulla. Flores staminei calyce gamosepalo membranaceo symmetrico 3.5 mm diametiente fere perfecte triangulo, angulis productis acuminatis, petalis 3 distinctis carnosis deltoideis, 8–10 mm. longis, acuminatis, basi 1.5–3.0 mm. latis, latioribus subcordatis Stamina 9, sagittata, filamentis 1 mm. longis tenuissimis antheris profunde sagittatis gravidis 2 mm longis, i.e. corolla occultis Pistillodium nullum.

Specimen typicum ad oppidum Mayarum antiquorum Tikal lectum, Petén, Guatemala, *H H. Bartlett* 12584, 12-15 Apr 1931, in Herb. Mich.: La Libertad, Petén, Guatemala, *C L Lundell* 2646 (6 Apr. 1933; florens) et 3421 (27 Maiae 1933, cum fructibus)

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE GEOLOGICAL SOCIETY

518TH MEETING

The 518th meeting was held at the Cosmos Club October 31, 1934, Vice-President GOLDMAN presiding

Informal communications L G HENBEST showed lantern slides of pseudomorphs of halite from the De Queen limestone member of the Trinity formation, De Queen, Arkansas.

Program: W. T SCHALLER: *Kramer borate deposits, California.* Discussed by Messrs. GOLDMAN, JOHNSTON, HENDRICKS, R. C. WELLS, GILLULY, HEWETT, and BAILEY

R. C. WELLS: *The abundance of certain elements, especially radioactive elements, and related geologic problems.* The first attempt to compute the average chemical composition of known terrestrial matter was made by F. W. Clarke in 1889. Chemists have been adding to the compilation ever since A recent publication by the Russian chemist A. E. Fersman lists the average abundance or scarcity, as the case may be, of 88 elements, and if account is taken of isotopes, there are now 262 species of matter to be considered More elements occur in ten-thousandths of a percent than in any other rank of abundance. The radioactive elements have been of great aid in determining the abundance of several elements. These elements have pedigrees. Also, as they evolve heat continuously, there must be a definite limit to their quantity in the earth. They appear to be concentrated near the surface and hence it may be inferred that there is a similar limit to the abundance of elements generally associated with the radioactive elements in the earth's crust. Recent work in the Geological Survey has involved

more particularly the elements uranium, thorium, lead, tin, barium, columbium, tantalum, cesium, and rubidium. (*Author's abstract.*) Discussed by Messrs MERTIE and WASHBURNE.

519TH MEETING

The 519th meeting was held at the Cosmos Club November 14, 1934, Vice-President GOLDMAN presiding.

Informal communications: GEORGE TUNELL told of his visit, during the summer, to laboratories engaged in crystallographic work in Oslo, Stockholm, Helsingfors, Leningrad, and Moscow.

D. F HEWETT described a manganese depositing hot spring at Hot Springs, Arkansas.

Program: W. P. WOODRING: *Geomorphology of the Palos Verdes Hills, California* Discussed by Messrs BRADLEY, HESS, ALDEN, and COOKE.

H. T. STEARNS: *The geologic history of Oahu (Hawaiian Islands).*

Oahu consists of two dissected volcanoes known as the Koolau and Waianae Ranges. The sequence of events in the geologic history of Oahu is summarized as follows:

TERTIARY TIME

1. Building of a dome-shaped island about 3,000 feet high by the extrusion of the lower basalt member of the Waianae volcanic series from southeast and northwest rifts with the center of activity at their intersection near the present site of Kolekole Pass. Extrusion of basalt of the Kailua volcanic series from a rift passing through the site of the present Mokulua Islands forming another island at about the same time 2. Collapse of the Waianae dome and extrusion of the middle basalt member from the Waianae rifts The cliffs formed by the collapse ponded the middle basalt and forced most of it to flow north and east Beginning of erosion to the west of these cliffs, starting the valleys of Nanakuli, Lualualei, Waianae, Makaha, Keaau, and Makua Shift of volcanic activity a mile south of the Kailua rift with the extrusion of the older layers in the Koolau volcanic series probably about this time. 3 Extrusion of the upper lavas of the Waianae volcanic series and continued erosion of the valleys named above The main bulk of the Koolau series was probably extruded at this time 4 Extinction of the Waianae Volcano and the beginning of erosion all over it Continued extravasation of lava from the Koolau Volcano 5 Overlapping of the Waianae dome by lavas from the Koolau Volcano resulting in the partial filling of its windward valleys and the joining of the two volcanoes to form a single island Continued erosion of the leeward side of the Waianae dome.

EARLY (?) PLEISTOCENE TIME

6. Cessation of activity of the Koolau Volcano. Continued erosion of the Waianae dome. 7. Long cycle of erosion resulting in the sweeping away by streams of most of the windward side of the Koolau and part of the leeward side of the Waianae domes High cliffs formed on the end of interstream divides by marine abrasion. Coral reefs started growing about this time if not before 8. Gradual submergence of Oahu by more than 1,200 feet resulting in the drowning and sedimentation of the valleys and the formation of the Koolau Pali by the partial burial of interstream divides of large amphitheatre-headed valleys Continued marine abrasion on exposed headlands and growth of coral reefs.

MIDDLE (?) AND LATE PLEISTOCENE TIME

9. A halt of the sea at 55 feet above present sea level known as the Kahuku stand 10 Recession of the sea probably about 300 feet below present sea level, known as the Kahipa stand. Erosion of the coastal plain deposits 11 Rise of the sea to 95 feet above present level known as the Kaena stand, extrusion of some of the Honolulu volcanics, vigorous growth of coral reef off shore, and grading of valley floors to this level. 12. Recession of the sea to 70 feet above present level, known as the Laie stand, more eruptions of the Honolulu volcanics, growth of coral reef off shore, and erosion continued 13 Halt of the sea at the 40-foot (?) level known as the Waialae stand. 14 Recession of the sea to about 60 feet below the present level known as the Waipio stand, additional eruptions of the Honolulu volcanics, dissection of coastal deposits, vigorous wave attack on headlands, and probably inhibition of coral growth 15 Rise of the sea to about 25 feet above the present level known as the Waimanalo stand, further eruptions of the Honolulu volcanics, drowning of the mouths of valleys, continued erosion of coastal deposits above the 25-foot level, and growth of coral off shore

LATEST PLEISTOCENE OR RECENT TIME

16 Recession of the sea to the present level Koko Fissure and Tantalus-Sugar Loaf eruptions, continued erosion, and probably slowing down in rate of growth of coral off shore (*Author's abstract*) Discussed by Messrs STEPHENSON and ALDEN

520TH MEETING

The 520th meeting was held at the Cosmos Club November 28, 1934, Vice-President SCHALLER presiding

Informal communications Miss M D FOSTER displayed a map showing the distribution in the United States of the disease known as "mottled teeth " The endemic areas do not coincide with areas of known fluorspar deposits. In Arizona, ground water containing 1 to 2 parts per million of fluoride causes mild cases, and over 2 parts per million severe cases

Program Miss A I JONAS: *Pre-Devonian structural zones in Scotland and eastern North America* Discussed by Mr GILLULY.

G W. STOSE: *Comparison of Cambrian section in Northwest Scotland with that of the Northern Appalachians* Discussed by Miss JONAS and Messrs. MERTIE and RUBEY

T. L. KESLER: *Granitic injection processes in the Columbia quadrangle, South Carolina.*

Older rocks of the eastern "slate belt" have been intruded by a biotite granite. Northward these older rocks were traced almost continuously into North Carolina where detailed study in several localities has proved them to consist mainly of rhyolitic and andesitic tuffs and breccias with interlayered flows and sills Southwestward from the quadrangle, the belt was traced farther into Saluda County where its original character is well preserved The "slate belt" has been altered throughout most of the quadrangle, though original bedding may be frequently recognized Normal strike averages about N 55 E except where deflected by granite masses and dips are steeply N W except for local reversals considered to be of little structural significance.

The granite has caused recrystallization parallel to bedding in wide areas of the older rocks where bedding may still be recognized. This is

believed to be due to the ascension of magmatic emanations along the convenient steep dip. It was suggested that the general schistose condition of the older rocks may be thus explained with the development of sericite, biotite, chlorite, and hornblende oriented with their long axes parallel to bedding Recrystallization is wide-spread, and is believed to indicate a general subjacent source of which the isolated granite masses are satellites In comparative proximity to these masses, the schists have been subjected to lit-par-lit injection and replacement by granitic material Still nearer the granite, an advanced stage of injection is expressed by granitic rocking which the structure of the older rock is preserved through inheritance of parallel platy ribbons of biotite or the linear arrangement of hornblende. Where the process has been carried to an extreme, replacement and recrystallization have obliterated most of the inherited structure, but the resulting granitic rock contains traces of the older rocks. (*Author's abstract.*) Discussed by MISS JONAS and Messrs JOHNSTON, CARL BROWN, GILLULY, LOUGHLIN, STOSE, and CURRIER

521ST MEETING

The 521st meeting was held at the Cosmos Club December 12, 1934, Vice-President GOLDMAN presiding N. H DARTON presented a deferred presidential address: *Erosion plans and overlaps in the eastern Maryland region.*

42D ANNUAL MEETING

The 42nd annual meeting was held at the Cosmos Club ofter the adjournment of the 521st regular meeting, Vice-President GOLDMAN presiding. The annual report of the Secretaries was read. The Treasurer presented his annual report showing an excess of assets over liabilities of $1443 38 on December 8, 1934 The auditing committee commended the Treasurer on the condition of his books.

The results of balloting for officers for the ensuing year were as follows: *President:* W T. SCHALLER; *Vice-Presidents:* M I GOLDMAN and H. D MISER; *Treasurer:* C. WYTHE COOKE; *Secretaries* W. D. JOHNSTON, Jr., and GEORGE TUNELL; *Members at large of the Council:* A. A. BAKER, C. L. GAZIN, R. M. LEGGETTE, S. W. LOHMAN, and J. S WILLIAMS; *Nominee as Vice-President of the Washington Academy of Sciences representing the Geological Society:* H. G. FERGUSON

T. B. NOLAN and W D. JOHNSTON, Jr., *Secretaries.*

BOTANICAL SOCIETY

254TH MEETING

The 254th regular meeting was held in the Assembly Hall of the Cosmos Club, January 2, 1934, President SMITH presiding; attendance 103 DOROTHY BLAISDELL, MARIE CLARK, BOWEN CRANDALL, and ARTHUR C. FOSTER were elected to membership

Notes and reviews: DAVID GRIFFITHS reviewed *The fantastic clan* by Thornber and Bouker, a naturalist's treatment of the cactus family. H. B. HUMPHREY called attention to a new book, *William Bartram, the interpreter of the American landscape,* by N. Bryllion Fagin

Program: ANNIE M. HURD KARRER: *Selenium injury to wheat and its inhibition by sulphur.*—A so-called alkali disease of livestock in certain re-

stricted areas of the Northern Great Plains area has been traced to the presence of selenium in the vegetation. The grain and straw of wheat plants grown in soil at Arlington Farm to which only 1 part per million selenium was added as sodium selenate gave no external evidence of having been affected by the selenium, but were extremely toxic to experimental animals. In order to produce visible symptoms of injury to the plants the selenium concentration in the soil had to be increased to between 10 and 20 parts per million.

The characteristic symptom of injury is a snow-white chlorosis of the young leaves With extreme injury the entire leaf may be white, maintaining its normal turgidity for some time before withering More often the tip of the leaf remains green, as does the midvein. A striking symptom occurring sporadically in the selenized seedlings of both wheat and corn was a pink coloration on the chlorotic parts of the leaves. When the selenate was added to pots containing older plants the white chlorosis appeared only on leaves emerging subsequent to the addition of selenium, those already formed merely turning yellow if the selenium concentration was high enough to affect them at all

The toxicity of sodium selenate for wheat grown in sand and water cultures varied inversely with the amount of sulphur, as magnesium and ammonium sulphate, in the nutrient solution In water cultures selenium concentrations of 1 p p m. are fatal after a few weeks in nutrient solutions made up without sulphate whereas 96 p.p m were required for this degree of injury in solutions containing 192 p.p m. sulphur. There was no visible selenium injury in any solution where the proportion of selenium to sulphur was 1:12 or less, whereas chlorosis was marked in all where the ratio was 1:8 or greater The point of minimum detectable injury was between 1:9 and 1:11 in all the experiments In soils, selenium injury was always inhibited by the addition of excess sulphur either as calcium, magnesium, potassium, or ammonium sulphate, or as elemental sulphur The amount required for a given addition of selenate varied with the latter's toxicity in the particular soil (*Author's abstract*)

CHARLES THOM: *An endomycete parasitic to man.*—Histoplasmosis was described by Darling as due to an intracellular parasite, *Histoplasma capsulatum*, apparently unicellular and protozoan in character. The organism isolated by DeMonbreun from a case of histoplasmosis grew in ordinary cultures as a mold, which was found to belong in or near the Endomycetaceae Ascospores were not found, but chlamydospores characteristic in shape and markings were interpreted as morphologically analogous to asci The parasite thus falls in a broad group which includes such species as *Coccidioides immitis* The organism as described presents a unique type of chlamydospore, which will insure its recognition when isolated from future cases. (*Author's abstract*)

VERA K. CHARLES: *Microsporum of the cat causing ringworm in man.*—Published in full in this JOURNAL **24**: 222–227. 1934.

255TH MEETING

The 255th regular meeting was held in the Assembly Hall of the Cosmos Club, February 6, 1934, President SMITH presiding; attendance 65.

Program: A S. HITCHCOCK: *Taxonomy as a fundamental factor in botanical research*—All comparative scientific research should be based upon definitely known material, and this principle applies emphatically to botanical research. Taxonomy is fundamentally related to botany in the same sense

that arithemetic is fundamental to other branches of mathematics. Much confusion has resulted, often involving much expense and waste effort, because of failure to secure accurate identifications of sources of drugs, fibers, and other economic plants. Discussed by Messrs. SWINGLE and WAITE

AGNES CHASE: *Some seeds caught in the upper air*.—Seeds taken in insect traps released at different altitudes from an airplane were sent to the Department of Agriculture for study More than half were those of grasses, for the most part *Paspalum urvillei* and *P. dilatatum.* Of 30 collections, made at from 200 to 5,000 ft., all included spikelets of the first species and about half included the latter species as well. One collection each of *P. pubiflorum* and *Hordeum pusillum* were obtained. Discussed by Messrs NORTON, THONE and DIEHL

E. B. LAMBERT: *Climatic phases in the ecology of the compost heap.*—Gas samples taken from all parts of mushroom compost heaps indicate an increase of carbon dioxide and decrease of oxygen toward the lower central part of the heap. In flat heaps three feet deep anaerobic conditions are usually found in areas deeper than one foot and more than three feet from the side of the heap. The highest temperatures (160° to 180° F.) are usually confined to a region two to four feet from the sides of the heap and one foot to three feet from the top The outer layers are cooler because of the lack of insulation from the outside and the lower central region is cooler because the lack of oxygen retards the microbial activity. At ground level, temperatures (100° to 120° F.) are usually lower than in the higher strata, presumably also because of lack of oxygen A more uniform distribution of oxygen and wider distribution of the high temperature region is induced by placing ventilating tiles at ground level In all probability conditions such as these influence the suitability of the finished compost for mushroom culture by establishing the trend of the microbial and insect population of the conpost heap (*Author's abstract*) Discussed by Mr. WAITE

256TH MEETING

The 256th regular meeting was held in the Assembly Hall of the Cosmos Club, March 6, 1934, President SMITH presiding; attendance 85 RALPH C. STAEBNER was elected to membership

Notes and reviews M B. WAITE discussed low temperature injury to peach buds and exhibited a branch of *Ligustrum lucidum*, showing characteristic recovery from freezing injury W. T. SWINGLE discussed an introduction of date palms from Persia into the United States in 1818, some of which still survive in the sea islands of Georgia.

Program M. L BOMHARD: *Recent palm discoveries in Louisiana.*—More than 25 species of palms are cultivated successfully in Louisiana, the most extensive plantings being in the southern part of the State, particularly around New Orleans The hardy species most frequently cultivated include *Washingtonia robusta*, *W. filifera*, *Phoenix canariensis*, *P. dactylifera*, *Livistona chinensis*, *Butia capitata* and its relatives (known "to the trade" as types of *Cocos australis*) including some that have edible fruits, *Trachycarpus excelsa*, *Chamaerops humulis*, and *Sabal palmetto*. Other species which are well adapted to the lower part of the State, but which are not yet so widely planted as those just listed include *Sabal exul*, *S blackburniana*, *S. causiarum*, *S. texana*, *Rhapis excelsa*, *Rhapidophyllum hystrix*, *Phoenix reclinata*, *P. sylvestris*, *Acrocomia totai*, and *Erythea armata*. All of these, with the exception of *Erythea armata* which flowers only in occasional years, regularly flower and fruit annually, at least in the New Orleans vicinity. A

35-year old specimen of *Phoenix rupicola* may be seen outdoors in New Orleans, but it is given protection during cold weather. The coconut palm, *Cocos nucifera*, and the Royal palm, *Roystonea regia*, have not been grown successfully for periods of more than a few years. *Cocos plumosa* (*Arecastrum romanzoffianum*) is no longer cultivated outdoors in New Orleans, but it may be seen in the orange-country fifty miles to the south.

The town of Monroe in Northeastern Louisiana, where the winters are sometimes severe, achieves a striking tropical effect through extensive plantings of one of the hardiest of palms, *Trachycarpus excelsa*. There are a great many more specimens of the true date palm, *Phoenix dactylifera*, growing in the southern part of the state than most persons realize. These trees flower annually and edible fruits are produced, including some excellent seedless forms. (*Author's abstract*.)

LOREN G. POLHAMUS: *Goldenrod and rubber*.—Following Edison's discovery that goldenrod contains rubber the cultivation and propagation of species of goldenrod have been studied. Variations in growth habit have been found and the possibility of selection on vegetative characters has been demonstrated, but no correlation has been found between growth character and rubber content. Studies have shown that variations in soil and climate affect the rubber content. Outstanding species from the standpoint of rubber content are *Solidago leavenworthii*, *S. edisoniana*, *S. altissima*, *S. serotina*, *S. fistulosa*, *S. nashii* and *S. sempervirens*. It has been found possible to propagate goldenrod readily by means of the underground stolons, as many as 500 new plants having been obtained from a single plant of *S. leavenworthii* in one year. Stem cuttings have failed to root but it has been found possible to propagate several species freely by layering. (*Author's abstract*.)

J. I. LAURITZEN and R. T. BALCH: *Influence of environmental factors on inversion of sucrose in harvested cane*.—The results from experiments conducted during the grinding season: 1930–31, 1931–32, and 1932–33 in Louisiana showed very little inversion of sucrose in sugarcane kept wet by sprinkling irrespective of the variety used. There was less loss of sucrose through inversion during rainy than during dry weather. There was an intimate relation between the loss of moisture and inversion of sucrose; the greater the rate of loss of moisture the greater the proportionate rate of inversion. By adding moisture to cane in which inversion was proceeding rapidly as a result of drying during various periods of time, inversion of sucrose was checked. In cane kept wet during storage at temperatures of 45°, 55°, 65°, and 75° F., very little inversion of sucrose occurred and the amount was similar at each of the temperatures. Among the commercial varieties of sugarcane grown in Louisiana Co 281 showed the greatest resistance to inversion of sucrose; P.O.J. 36M, and C. P. 807 the least, with P.O.J. 213, P.O.J. 234, Co 290 ranging between these extremes. No chemical or physiological changes took place during storage that were inimical to sugar manufacture. (*Authors' abstract*.)

257TH MEETING

The 257th regular meeting and annual dinner was held in the ballroom of the Kennedy-Warren, April 3, 1934, President SMITH presiding; attendance 142.

Program: ORAN RABER: *Teaching botany and botanizing around the world on a floating university*.

258TH MEETING

The 258th regular meeting was held in the Assembly Hall of the Cosmos Club, May 1, 1934, President SMITH presiding; attendance 90 H. P. BARSS, F. A. McCLURE, JOHN MONTEITH, JR., and LOREN G. POLHAMUS were elected to membership.

Notes and reviews. M. B. WAITE discussed the life history of the large red oak trees formerly lining 12th St., S.W., noting particularly evidence of injury from the extraordinary cold weather of 1899, and the slow growth since the advent of paved streets. H. B. HUMPHREY presented a summary of the precipitation in Washington for the period January 1930 to April 1934, emphasizing the deficiency of 17 inches for the period. J B S NORTON discussed the effect of altitude on opening English elm buds. F WEISS exhibited greenhouse grown Ixias and called attention to the suitability of this plant for outdoor culture

Program: A. E. LONGLEY: *The chromosomes of maize*

F. V. COVILLE: *The Death Valley of California after forty years.*

259TH MEETING

The 259th regular meeting was held in the Assembly Hall of the Cosmos Club, October 2, 1934, President SMITH presiding; attendance 73

Notes and reviews· A. S. HITCHCOCK reviewed Agnes Arber's new book *The Gramineae* M. B. WAITE discussed the effects of prolonged and excessive rainfall with high humidity during the record-breaking September with especial reference to the curing of tobacco in Maryland. W. T. SWINGLE reviewed the classical work on horticulture and botany of Brazil, edited by M. Pio Correa, *Diccionaire das Plantas Uteis do Brasil et das exoticas Cultivados.*

A A. BITANCOURT, subdirector, Instituto Biologico, Sao Paulo, Brazil, made a brief address in response to the welcome extended to him by the President on behalf of the Botanical Society. J A STEVENSON exhibited some of Mr Bitancourt's publications on Citrus diseases.

Program L. H. FLINT: *Sensitivity of dormant lettuce seed to light and temperature*—In typical cases of seed dormancy internal processes are effective after a longer or shorter period in overcoming the seemingly inanimate state without special agencies. In the case of lettuce seed which appears subject to classification as dormant, however, it has been found that light is a factor promoting germination. The sensitivity of such lettuce seed to light a few hours after soaking in water is so great that a few seconds' exposure to sunlight is sufficient to insure germination in subsequent darkness at 20° C. This sensitivity is thus comparable with that of photographic film.

It has been found that the longer wave-lengths of visible light, ranging in length from about 5200 to about 7000 Å and characterizing yellow, orange and red light, are effective in promoting germination. The shorter wave-lengths of visible light, ranging from about 5200 to about 4000 Å and characterizing green, blue and violet light, have been found to be effective in inhibiting germination. Seeds exposed to red light for a time sufficient to insure subsequent germination in darkness would not germinate in blue light.

The role of temperature in relation to light-sensitivity in dormant lettuce seed was studied by soaking seeds in water at various periods and then exposing each lot to a uniform illumination All seeds were put in a moist

chamber at 20° C following this illumination. The results obtained indicated that whereas at 5° C. the sensitivity of the seed to light was maintained for several weeks, at 25° C. the sensitivity was so altered after 24 hours that the standard illumination was without appreciable effect. This relationship may account for some of the beneficial effects ascribed to soaking seed at low temperatures

The establishment of a definite inhibitory effect of certain wave-lengths of light on germination appears of added significance because of the fact that these same inhibiting rays have been found to be the ones effecting the phototropic response of green plants The results thus emphasize the viewpoint that green plants turn toward light of specified wave-lengths not because they could thereby utilize more illumination, but rather because the light inhibited growth on the side of the stem directly exposed to the light. (*Author's abstract*)

E H. WALKER: *Some problems and methods in the taxonomy of Chinese plants.*

260TH MEETING

The 260th regular meeting was held in the Assembly Hall of the Cosmos Club, November 6, 1934, President SMITH presiding; attendance 72.

Notes and reviews F. THONE exhibited *Wild flowers* by Homer D House a work similar to *The Wild Flowers of New York* issued some years ago by the New York State Museum

L H BAILEY was present as a guest and, after being welcomed by the President, addressed the Society informally He gave a synopsis of recent botanical history contemporaneous with his own career, expressing judgment on present botanical work and forecasting the future He referred to his college days under the tutelage of Asa Gray, his service as professor of horticulture "in spite of which he remained a botanist," his term as Dean of the New York State College of Agriculture He spoke of the enthusiasm of the older botanists and naturalists for their work. He urged the importance of knowing the habits and range of variation of plants in the field. In discussing evolution, he said that we must get back to nature; as yet we can not apply the discoveries of the laboratory to influencing the course of evolution. In commendation of present-day taxonomy, Dr Bailey spoke of the attention now given to the proper collection of specimens, and in determining the variation and the range of species; he especially recommended the care and completeness shown in modern taxonomic descriptions

Program EARL S JOHNSTON: *Wave-length effects of light on phototropism* — Experiments on the evaluation of the wave-length of light in its effect on phototropism were carried out, using an improved plant photometer. Oat seedlings were grown between two lights, one standard, the other of a restricted wave-length range The intensity of the standard was adjusted until seedlings showed no phototropic bending At such balance points the intensity ratios of one light to the other were determined. The phototropic sensitivity curve rose from 4100 A to a maximum at 4400 A. It then dropped off to a minimum at about 4575 A and again rose to a secondary maximum in the region 4700 to 4800 A. The fall was quite rapid from this point to 5000 A, from where it tapered off very gradually to the threshold on the long wave-length side at about 5461 A

C. F. ANDRUS: *Cell and nuclear behavior in Ceratostomella and certain other fungi* —A discussion of cell multiplication and nuclear behavior in the ascus of the species of *Ceratostomella* and *Endoconidiophora*, with some review of

chromosome number and reduction in other Ascomycetes. Various types of direct and indirect cell cleavage that occur previous to ascus formation in C. moniliformis were described. The crosier type of cell division is modified to conform to the detached and unwalled condition of the dividing protoplast. Changes in cell shape accompanying cell division were emphasized. A description of nuclear divisions in the ascus included remarks on chromosome structure and number. The vesiculate nature of the spore-producing region of the ascus and the manner of ascospore formation in *C. moniliformis* and *C. fimbriata* seem to distinguish the group from more familiar genera of the Ascomycetae. (*Author's abstract*).

261ST MEETING

The 261st meeting was held in the Assembly Hall of the Cosmos Club, December 4, 1934, President SMITH presiding; attendance 50.

Program: N. R SMITH: *Present trends in soil bacteriological research* (Address of retiring President)

34TH ANNUAL MEETING

The 34th Annual Meeting was held immediately following the adjournment of the 261st meeting The recording secretary reported that the Society closed the year with an active membership of 206 and an honorary membership of 4 The names of 8 members had been placed on the absentee list because of temporary absence from the city The Society lost two members by death, H C. SKEELS and KARL KELLERMAN Twelve new members were elected; three members retired from professional work and were elected to honorary membership under the terms of the By-laws MISS MARY K. BRYAN, DR WM TAYLOR and MR. C O TOWNSEND

The following officers were elected to serve for the ensuing year: President, W W. DIEHL; Vice-President, FREEMAN WEISS; Recording secretary, CHAS T. SWINGLE, Corresponding secretary, NELLIE A BROWN; Treasurer, NELLIE W NANCE; N R. SMITH was nominated as vice-president for the Botanical Society to the Washington Academy of Sciences.

Freeman Weiss, *Recording Secretary*

SCIENTIFIC NOTES AND NEWS

Prepared by Science Service

NOTES

The Midwinter Meetings—Washington science was well represented at the various midwinter meetings, especially those of the American Association for the Advancement of Science and affiliated societies at Pittsburgh The principal address, at the first formal meeting on Thursday evening, December 27, was delivered by Dr. WILLIAM A WHITE, superintendent of St. Elizabeth's Hospital, on the subject, *Man, the great integrator* On Friday afternoon, December 29, an illustrated lecture was presented by W. R. CHAPLINE, chief, range research, U S Forest Service, on *Forestry fosters new approach to watershed conservation* Many scientists from Government departments, research institutions and the several universities in the District of Columbia presented papers before the various section and society meetings.

In the exhibit hall, six Washington institutions had displays illustrating some of their many activities. The American Association for the Advance-

ment of Science itself had an exhibit showing various phases of its work in encouraging the development of science, and also giving information on plans for future meetings Exhibits sponsored by members of the Smithsonian Institution included a model of a solar heating apparatus, a demonstration of the work of the Laboratory of Radiation and Organisms, and a display of lepidoptera. The exhibit of the Carnegie Institution of Washington was devoted to the recent rapid developments in the fields of genetics and embryology, particularly in the field of chromosome topography and gene mapping. The National Bureau of Standards demonstrated work done on deuterium or *heavy hydrogen*, and also displayed a set of new resistance standards The U. S Bureau of Mines set forth work done along five separate lines of research on coal and other minerals The National Geographic Society's exhibit consisted of models and the stratosphere balloon and apparatus used in their joint exploration flight with the U S. Army Air Corps last summer

Of special interest at the Annual Science Exhibition of the American Association for the Advancement of Science was an exhibit of research on deuterium and its compounds by laboratories which have been principal contributors in this field of investigation In this exhibit covering the fields of physics, chemistry, and biology, 13 laboratories were represented, 6 of these having major sized exhibits

Other midwinter meetings in which Washington scientists participated included those of the Geological Society of America (New York), the Society of American Bacteriologists (Chicago), the Archaeological Institute (Toronto), the American Astronomical Society (Philadelphia), the Chemical Engineering Symposium on Distillation (Cambridge), and the American Historical Association.

Science Advisory Board.—Broad scientific foundations are being sought by the Government, for its future policies of land use In this search scientists on the Land Use Committee of the Science Advisory Board are taking an active part.

The Land Use Committee acted as a sort of informal liaison organization, enabling fifteen separate government agencies concerned with different aspects of land use to pool their knowledge and obtain an approach to the problem as a whole

The Committee employed Dr CARL O. SAUER of the University of California, to make a comprehensive study of the subject as it is known in this country at present With Dr. SAUER was associated W. L. G JOERG of the American Geographical Society

Outstanding on the agenda of problems recommended for first-order investigation is a refinement of studies of climatological records already in existence, to give more reliable bases for decisions as to the habitability of marginal and submarginal lands If such lands, still in the public domain or now in process of re-purchase, can be withheld from re-settlement when they do not give reasonable promise of yielding a living, repetition of the tragedies of recent drought, and the older ones of the *grasshopper years* of the last century, can be spared the nation

Important also is the project for a study of permanent natural means of checking soil erosion. At present, major effort is being bent to the construction of gulley dams, partly because the situation in many localities is desperate enough to require engineering works to help it, partly in order to supply jobs for unemployed men. But in the long run, erosion must be held

in check by the roots of grasses, bushes and trees; and it is one of the objectives of contemplated study to find the right species and develop the right planting methods.

National Resources Board.—The National Resources Board has issued a series of reports, on the relation of public works to land and water resources, on land planning, on water planning, on mineral policy, and on a national mapping plan. Reversal of the traditional method of land development is advocated in the land planning report, it calls for the reabsorption into public domain of much land now badly settled and socially expensive, greater care in the release of lands for future settlement, and social control over private transactions in real estate. The necessity for erosion control is also emphasized. In the mineral resources report, stress is lid on the desirability of *holding back* in the use of such minerals as exist in this country in insufficient quantities for normal needs, and at the same time controlling the exploitation of deposits where present surpluses exist Studies of tariff readjustments and foreign trade agreements as they affect mineral resources are also recommended The mapping report calls for a ten-year plan to complete the topographic survey of the United States. Only 26 per cent of the total area of the United States exclusive of Alaska and island possessions has been adequately mapped; the rest is mapped either inadequately or not at all The working program proposes zones of first, second and third priority, based on the urgency of the need for completion The National Resources Board functions under the chairmanship of Secretary ICKES; its personnel includes Secretaries DERN, WALLACE, ROPER and PERKINS, Relief Administrator HOPKINS, FREDERIC A. DELANO, CHARLES E. MERRIAM and WESLEY C MITCHELL.

National Bureau of Standards—A new method for investigating the effects of radium rays and X-rays in deep tissues has been developed at the National Bureau of Standards by L S TAYLOR It stimulates conditions in the human body with wax blocks, which have been named "phantom bodies," and a mixture of carbon bisulphide, tetrahydronaphthalene and ligroin to serve as the radiation-absorbing fluid An ionization screen, immersed in the fluid, obtains a measure of the degree of ionization caused by the radiations. With further development the instrument may prove of great value in determining the nature and dosage of radiations to be used in treating deep-seated tumors.

Smithsonian Institution—Thirty ancient Indian village sites and numerous island graveyards along the lower Columbia river have been explored by HERBERT W. KRIEGER, who returned to Washington in January, after six months in the field. The expedition was undertaken in order to salvage archaeological data and material in the area which will be flooded upon the completion of the Bonneville Dam. The region proves to have been thickly settled. In one area, now arid and unpopulated, Dr. KRIEGER counted the remains of more than five hundred houses. One island cemetery, he learned, had been burned by early white settlers; here he found evidences of fire intense enough to fuse glass beads

U. S. National Park Service.—Reports of measurements made of glaciers in national parks this past fall by Park Naturalists indicate continued recession. In each instance glaciers were found to have moved and melted back from ten to fifty feet or more.

Geological Survey.—A contract was awarded the Fairchild Aërial Surveys, Incorporated, for furnishing aerial photographs, to be taken with a single-lens camera, of about 5,800 square miles in South Carolina. The photographs will be used to supplement ground surveys for topographic mapping provided for in the Public Works program of topographic surveys.

The possibilities of langbeinite, a potassium-magnesium sulphate identified in certain drill cores from Federal land and private land in New Mexico, as an important fertilizer material, are receiving considerable industrial attention at this time As this mineral is slowly soluble, it is believed suitable for direct application with the seed, in lieu of the customary application of potash fertilizer at the side of the seed row, and offers advantages in the reduced amount of fertilizer required and in the longer period that the potash remains available to the plant during the growing season.

News Briefs

The Bureau of Mines has awarded contracts for the drilling of a new gas well on the helium-bearing Cliffside structure, in Potter County, Texas, which is expected to bring in a material increase in the Government's available helium supply

The U S Army Air Corps and the National Geographic Society will undertake another stratosphere balloon flight this spring, it is announced.

A precision cosmic-ray meter, has been installed at the Cheltenham Magnetic Observatory by Dr Richard L Doan, Dr. A H. Compton's assistant at the University of Chicago, S E. Forbush of the Department of Terrestrial Magnetism, and George Hartnell of the U. S Coast and Geodetic Survey, during the first week in January and is now in operation

Personal Items

By action of the Trustees of the Carnegie Institution of Washington at their annual meeting in December, Dr. John A Fleming was made Director of its Department of Terrestrial Magnetism beginning January 1

Dr Hugh L. Dryden has been promoted to the position of chief of the division of mechanics and sound of the National Bureau of Standards.

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PHYSICS.—*Frontiers of aerodynamics.*[1] HUGH L. DRYDEN, National Bureau of Standards.

Tonight we hold the 1077th meeting of the Philosophical Society, beginning the 65th year of activity. By long-standing custom, a special meeting is set apart for the president's annual address, originally the meeting just preceding the annual meeting, but for many years now it has been deferred until the president is relieved of the cares of office. With few exceptions the presidential address has been devoted to a survey of some specialized branch of science, thus fulfilling the prophecy of Professor Henry in his first presidential address that the society should become "a means of instruction to all its members, the knowledge of each becoming, as it were, the knowledge of the whole."

I wish to continue this tradition by outlining to you the present situation on three frontiers of the science of aerodynamics. The territory of aerodynamics is bordered on the north by the great unknown land of unsolved problems of the science itself, on the east by the occupied territory of other specialized sciences such as meteorology, oceanography, hydrodynamics, heat transfer, etc., and on the west by the domain of the practical arts, the home of the engineering fraternity.

I shall perhaps devote what seems to be an undue amount of space to the northern frontier. In these days as never before, many people find it difficult to understand why any attention should be paid to a territory so cold, so barren, so uninviting, so unpromising, so useless, as that of the unknown fields of pure science. Effort expended in that direction bears no promise of immediate large dividends. Many expeditions return fruitless with their original resources expended, apparently a total loss. Others return with a collection of curiosities of no present market value. A recent critic voices his

[1] Address of the retiring president, delivered before the Philosophical Society of Washington, January 5, 1935. Publication Approved by the Director of the National Bureau of Standards of the U. S. Department of Commerce. Received January 17, 1935.

estimate of the returns of some of these expeditions into the unknown as follows:

"Of that which is comprehensible, a high percentage is useless because it deals with pure research work which leads nowhere, or with research into problems which were settled years ago by successful designers.

"The matter of the report is scientific hokum, the manner is literary hooey."

The same critic is very enthusiastic in his support of activities on the western frontier, in what he terms *ad hoc* research as contrasted with *basic* research. In his own words:

"*Ad hoc* research may be defined as hunting for a needle in a haystack, when you do know that a needle is there, whereas basic research is just turning over haystacks on the off chance that there may be a needle or a pin or something worth picking up."

Unfortunately, when one finds the needle which is known to be present in the haystack, he painfully discovers, by the same process by which he discovered the presence of the needle, that there is a pin in the haystack and the haystack must be overturned again, and when the pin is found, behold, there must be a spike present, and so on ad infinitum. Basic research is rather the turning over of haystacks in a particular manner, painstakingly sifting the hay and listing the needles, pins, spikes, and other objects found in the haystack, so that in time it will not be necessary to turn over all of the haystack because the characteristic locations of needles, pins, spikes, etc. will be known.

One can not by ridicule or lack of appreciation detract from the value of a permanent contribution to the knowledge of humanity, or minimize the importance of the many unsuccessful attempts which are an essential part of the attainment of the goal. It is hoped that this brief review of the frontiers of aerodynamics will illustrate by precept and example how the activities on the northern frontier are essential to the welfare of the neighboring territories.

The Philosophical Society had the privilege of hearing the first reports of one of the early expeditions into the north, in a region whose resources we are beginning to appreciate.

A little more than thirty years ago, at the 581st meeting of the Philosophical Society on February 27, 1904, A. F. Zahm reported more fully than he had done at the 554th meeting about two years earlier the results of his three years' experiments on *Atmospheric friction, with special reference to aeronautics*. At the same meeting C. M. Manley spoke on the *History and present status of aeronautics*, and included a discussion of Langley's aerodrome and the accidents in launching

Hugh L. Dryden

President Philosophical Society of Washington

1934

it the preceding fall. Professor Marvin, then president of the society, was in the chair. Langley and Alexander Graham Bell were present and discussed the papers. I often wish I could have been present at that historic and memorable meeting.

In his paper Zahm stated:

"To complete the theory of the skin-friction board, two steps further remain to be taken. First, the equations of motion for a viscous fluid must be integrated to find the velocity at all points in the disturbed region about a thin material plane. Then the speed of flow must be measured at all points next the plane and at some distance away. The writer expects soon to map the stream-lines and measure the velocity. If, then, the equations can be integrated so as to give the speed as a function of the space coordinates, the computed and observed values can be directly compared. It is hoped that some one may obtain sufficiently general solutions of the equations to be of practical value, particularly for the simpler case in which the plane is indefinitely wide, in which the edge conditions are negligible."

I have never asked Dr. Zahm whether he made the attempt "to map the streamlines and measure the velocity." Probably difficulties were encountered, for only within the last few years have adequate methods of measurement been developed. From the data which will be given presently (Fig. 1) we may estimate that the thickness of the disturbed region could not have exceeded 3 inches and was probably much less at the downstream end of the longest board, which was 16 feet long. Certainly the speed was not less than 80 per cent of the speed of the free stream at points more than 0.1 inch from the surface. The completion of this part of the important program outlined by Dr. Zahm had to await the development of a technique of measuring speed very close to a surface.

The pioneer measurements were made by J. M. Burgers and B. G. van der Hegge Zijnen at Delft in 1924 with the aid of a hot wire anemometer. Measurements of the local speed were made at several hundred points for five speeds of the free air stream. Fortunately, it is possible to utilize the methods of dimensional analysis to devise a method of plotting which gives one a general view of the results. The speed V at any point, whose coordinates are x and y with respect to rectangular axes whose origin is at the front edge of the plate, is a function of the speed V_0 of the air stream, of the density ρ and viscosity μ of the air, and of x and y. By dimensional reasoning we find that

$$\frac{V}{V_0} = \phi\left(\frac{V_0 x \rho}{\mu}, \frac{V_0 y \rho}{\mu}\right)$$

Therefore with $V_0 x\rho/\mu$ and $V_0 y\rho/\mu$ as abscissa and ordinate, respectively, we may plot contours along which V/V_0 is constant and equal to assigned values. The resulting diagram is shown in Fig. 1, the ordinates being magnified 200 times with respect to the abscissae. In more familiar terms, if the speed V_0 is 20 feet per second, the numbers *along the abscissae are in tens of inches; each square along* the ordinates is one-hundredth of an inch; and the contour lines con-

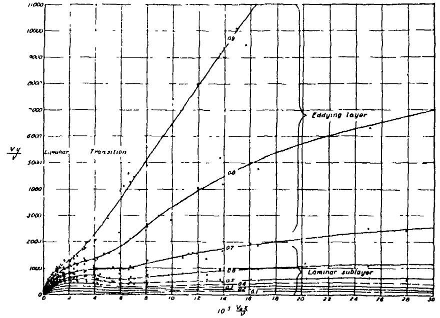


Fig. 1 —Speed distribution near skin-friction plate, van der Hegge Zijnen's measurements See text for explanation of symbols, except ν which is the kinematic viscosity. $\nu=\mu/\rho$

nect points whose speeds are 18, 16, 14, 12, 10, 8, 6, 4, and 2 feet per second.

The contour for $V/V_0=1$ is not shown, since V approaches V_0 asymptotically. The limited region with an ill-defined outer boundary within which the influence of the plate is felt is the so-called *boundary layer.* It becomes a more real thing when measurements have been made within it and its inner structure has been examined.

Near the upstream edge the contours are approximately parabolic in shape and correspond fairly well to a solution of the Prandtl boundary-layer equations given by Blasius in 1908. The flow in this region is designated *laminar flow.*

From a $V_0 x\rho/\mu$ of about 300,000 to about 500,000, a new phenom-

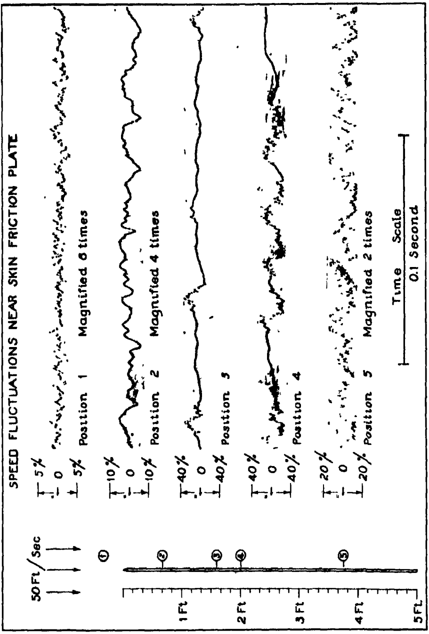


FIG. 2.—Oscillograph records of fluctuations of speed at several points near skin-friction plate.

enon arises, the air close to the surface being accelerated instead of retarded. This region is termed the *transition region.*

There follows a different type of speed distribution. In the region marked *eddying layer*, there is a logarithmic relation between V and y at a given value of x. Near the wall the relations are different, the distribution resembling that in the laminar region. This *laminar sub-layer* accounts for two-thirds of the fall in speed but for only a small part of the thickness of the layer.

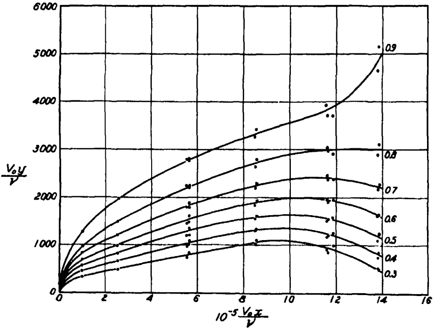


Fig. 3.—Distribution of speed near skin-friction plate, turbulence 0 5 percent. Measurements at National Bureau of Standards

Apparatus has been developed for measuring the fluctuation of the speed at a given point with time as well as for measuring the mean speed. With this apparatus we may obtain some information as to the nature of the flow of the type indicated in Fig. 2. It may be noted first that small fluctuations are present in the air stream approaching the plate. To this initial turbulence we shall return later. In the laminar region we find fluctuations of amplitude several times that in the approaching stream but much slower. In the eddying region the fluctuations are very rapid. The transition, which appears to be gradual in the measurements of mean speed, is actually a very sudden one. There is an intermittent change from laminar to eddying flow,

occurring at infrequent intervals near the beginning of the transition region and at more and more frequent intervals as the end of the transition region is approached. The phenomenon is identical with that long known to occur in the flow of water in pipes, and frequently exhibited by the aid of streams of dye. The wavering of the color

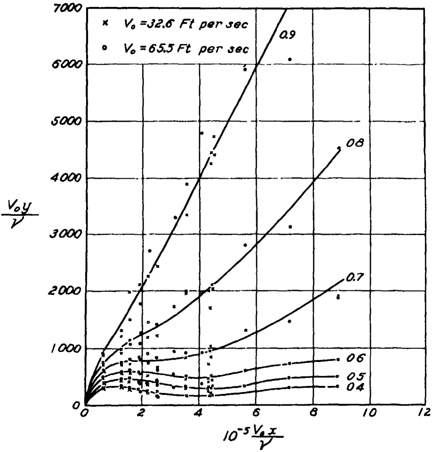


FIG. 4—Distribution of speed near skin-friction plate, turbulence 3.0 percent Measurements at National Bureau of Standards

bands in the laminar flow, the sudden diffusion through the pipe when the flow becomes eddying, the wandering of the point of transition, all are now familiar but not understood.

The true distinction between laminar and eddying flow is not based on the presence or absence of fluctuations. In eddying flow, the fluctuations are of such a nature that there is a net transfer of momentum by the motion of small masses of fluid in addition to the molecular

transfer. In laminar flow, this additional net transfer of momentum does not occur.

It has been found experimentally that the transition from laminar to eddying flow is profoundly affected by the magnitude of the initial *turbulence*, the name given to the small fluctuations of frequencies of the order of 20 to 1000 per second superposed on the desired steady flow. The amplitude of these fluctuations does not ordinarily exceed a few per cent of the average speed, yet a change in this amplitude produces effects of astonishing magnitude in many aerodynamic measurements. For example, Fig. 3 and Fig. 4 show diagrams similar to Fig. 1 plotted from measurements made under the direction of the author in air streams for which the root-mean-square amplitude of the fluctuations was, respectively, 0.5 and 3.0 per cent of the mean speed. The corresponding values of $V_0x\rho/\mu$ at which transition occurs are 1,100,000 and 100,000, respectively. In other words, at a given speed with a given skin-friction plate the transition occurs at a distance from the leading edge 11 times greater in the first case than in the second. The skin friction and the flow are quite different in the two cases.

There is no suggestion that the laminar flow is stable for small disturbances up to a certain magnitude and that it suddenly becomes eddying everywhere when the disturbance exceeds a certain magnitude. While for a fixed turbulence the transition itself is quite sudden, as we have seen in Fig. 2, there is a progressive and regular functional relationship between the value of $V_0x\rho/\mu$ at transition and the turbulence of the airstream.

The turbulence of the airstream has been found to be an independent variable of considerable importance in many aerodynamic measurements, chief interest among engineers at the present time being its effect on the maximum lift of airplane wings. Much attention has been given, therefore, to methods of assigning numerical values to the turbulence and to the correlation between the aerodynamic measurements and the numerically assigned values.

It is possible to measure directly the root-mean-square fluctuation of the speed at any point with time by means of a special form of hot-wire anemometer, with a wire of small diameter (0.017 mm), an amplifier, an electrical network to compensate for the lag of the wire, and an alternating current milliammeter. The speed fluctuation is converted into an alternating current whose intensity is measured. The ratio of the root-mean-square fluctuation to the mean speed is defined as the numerical value of the turbulence. The ratio is usually stated as a percentage.

The equipment required for the hot wire measurement is rather cumbersome and requires considerable care and skill on the part of the operator. A more convenient method is to utilize some aerodynamic measurement which is sensitive to turbulence. The measurement most generally used is that of the resistance of a sphere. If one measures the resistance R of a sphere of diameter D in an airstream of speed V_0, the air being of density ρ and viscosity μ, the results may be conveniently expressed as a plot of the resistance coefficient $C_D = \frac{R}{\frac{1}{2}\rho V_0^2 \frac{\pi}{4} D^2}$ against the Reynolds Number $V_0 D\rho/\mu$. At very low Reynolds Numbers C_D is approximately constant and equal to about 0.5. At Reynolds Numbers within a range of values dependent on the turbulence the coefficient decreases rapidly to values in the neighborhood of 0.1. To obtain a definite numerical value it has been proposed to define the Reynolds Number for which C_D is equal to the average of these two values, namely 0.3, as the *critical* Reynolds Number and to use it as a measure of the turbulence.

The measurement of the resistance of a sphere in wind tunnels of varying size is somewhat inconvenient and in any case there is some complication because of the forces on the supports. Therefore there has recently been introduced a pressure-sphere, in which a simpler measurement of differential pressure is utilized. The difference in pressure Δp between an impact hole at the front of the sphere and a hole (or preferably a number of holes) on the downstream side at an azimuth angle of about 157½ degrees from the impact hole is divided by the velocity pressure $q = \frac{1}{2}\rho V_0^2$ to give a pressure coefficient. The critical Reynolds Number is defined as that for which $\Delta p/q = 1.22$. The values obtained are approximately the same as those for which $C_D = 0.3$.

The first comparisons between these methods of measuring turbulence showed extremely good correlation, but as more information became available it became apparent that the critical Reynolds Number of a sphere as defined above depends on the size of the sphere and on other properties of the fluctuations as well as on the root-mean-square amplitude. In some recent work on this problem at the National Bureau of Standards, artificial turbulence was introduced in an airstream by a series of geometrically similar wire screens. For each screen, identified by the mesh distance, different values of the root-mean-square amplitude of the fluctuations were obtained by working at different distances. To avoid variations of mean speed and of turbulence across the stream, the distance had to be greater than 70 times the diameter of the screen wire. The relation between the criti-

cal Reynolds Number of a 5-inch sphere and the hot-wire value of the turbulence for the several screens is shown in Fig. 5. Measurements on a larger sphere show that the correlation is a function of the ratio between the mesh distance and the sphere diameter. It thus

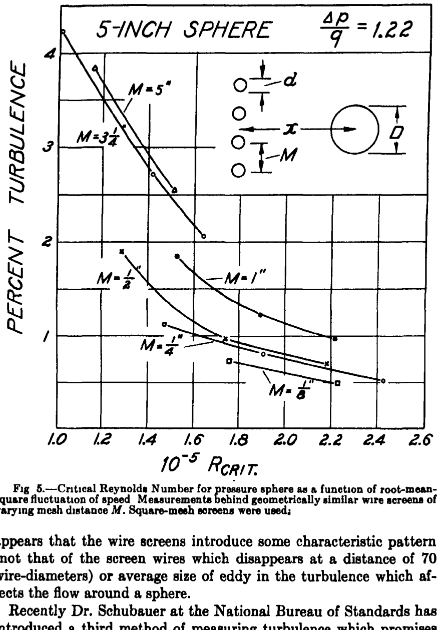


Fig 5.—Critical Reynolds Number for pressure sphere as a function of root-mean-square fluctuation of speed Measurements behind geometrically similar wire screens of varying mesh distance M. Square-mesh screens were used.

appears that the wire screens introduce some characteristic pattern (not that of the screen wires which disappears at a distance of 70 wire-diameters) or average size of eddy in the turbulence which affects the flow around a sphere.

Recently Dr. Schubauer at the National Bureau of Standards has introduced a third method of measuring turbulence which promises

to be quite useful. He found that the temperature distribution at some distance downstream from a hot wire of small diameter was a function of the turbulence. The dynamic wake of the small wire disappears at short distances, the wire acting substantially as a line source of heat in a uniform stream. The thermal wake widens at a rate dependent on the turbulence, and the width of the thermal wake between points where the temperature rise is one-half the maximum temperature rise furnishes a suitable measure of the turbulence. The correlation with hot wire measurements is very good and the equipment required is relatively simple, a thermocouple and sensitive galvanometer being the essential elements.

It is perhaps obvious that a completely satisfactory method of measuring turbulence can not be developed until we understand more completely the mechanism of the transition from laminar to eddying flow and the influence of this transition on the flow, pressure distribution, and force acting on bodies immersed in a fluid stream.

We have already noted the effect of the transition on the skin friction. Another basic effect is that on the process of separation. When, for example, air flows around a cylinder, there is a thin well-defined boundary layer only over the forward part. The flow separates from the surface somewhat forward of the median plane, the air near the surface in the region just downstream from the separation zone moving forward in a direction opposite to that of the main stream. Separation occurs when the pressure increases in the downstream direction and the essential features can be derived from the boundary layer equations of Prandtl. The retarding effect of the adverse pressure gradient finally predominates over the frictional transfer of momentum from the faster moving particles. The reversal of flow, on account of the consequent accumulation of fluid, separates the flow from the surface.

If transition to eddying flow in the boundary layer occurs before the separation zone for laminar flow is reached, the process of separation is delayed to a greater azimuthal angle. The eddying flow promotes a more thorough mixing and transfers momentum more readily to the fluid layers near the surface of the cylinder. The behavior of the resistance coefficient or pressure coefficient of a sphere is to be attributed to the effect of the transition on the process of separation and the influence of turbulence on the coefficients is to be attributed to the influence of turbulence on the transition.

The boundary layer at the front of a cylinder differs from that on the skin-friction plate because of the presence of a pressure gradient

in the direction of flow which arises as a result of the increasing speed. This pressure gradient acts to accelerate the flow within the boundary layer and to retard the increase in thickness of the layer. The presence of a small pressure gradient in the wind tunnel airstream is responsible for the supposed discrepancies between experiment and theory in some experiments on skin-friction plates. The theoretical equations show that small pressure gradients have effects much larger than one might suppose.

The existence of an accelerating pressure gradient also affects the transition, delaying it to higher values of $V_0 x\rho/\mu$. The few experiments available indicate that the transition is controlled by the value of $V_0\delta\rho/\mu$ where δ is a suitably defined *thickness* of the boundary layer, for example $\int_0^\infty(1-V/V_0)dy$. Much more work remains to be done to verify this hypothesis and to study the influence of other factors, such as the curvature of the flow, temperature gradients, etc., on the transition.

The equations of Prandtl describing the flow in a boundary layer are adequate to account for the experimental results so long as the flow is laminar. The unsolved problems of the laminar boundary layer are principally mathematical in character. In the case of eddying flow, even the basic equations are unknown, at least in usable form. Some suppose that the eddying flow represents an unsteady motion which satisfies the fundamental equations of Stokes-Navier for a viscous fluid. Others consider it necessary to introduce additional hypotheses. Notable advances have been made by combining theoretical considerations with empirical results obtained by experiment.

All of these methods begin from the hypothesis of Osborne Reynolds that the flow could be regarded as consisting of a mean flow and a superposed fluctuating motion which could be clearly distinguished. The equations of the mean motion are identical with the equations of Stokes except for certain terms depending on the so-called eddy stresses. The eddy shearing stresses for example are $\rho\overline{u'v'}$, $\rho\overline{u'w'}$, and $\rho\overline{v'w'}$ where the bar denotes mean value, ρ is the density, u', v', w' are the components of the fluctuations at a point. Obviously these stresses are zero unless there is a correlation between the several components.

The eddy shearing stress is analogous to the viscous shearing stress, the eddy fluctuations being analogous to molecular fluctuations. The effect of molecular motions appears in the smoothed equations of motion as the viscosity coefficient. While the viscosity depends only on the temperature, the eddy stresses vary from point to point, being unknown functions of the mean flow. Reynolds general theory

gives no information about the fluctuations themselves, showing only the effect of known fluctuations on the mean motion.

One hypothesis as to the relation between the fluctuations and the mean motion which has been often used is implied in the introduction of the eddy viscosity, a quantity which relates the eddy shearing stresses to the mean motion in the same way that the viscosity relates the viscous shearing stresses to the mean motion. This procedure implies certain relations between the components of the fluctuations at a point, but the eddy viscosity may still vary from point to point. Although a formal simplification results, some assumption must still be made as to the variation of the eddy viscosity throughout the flow.

The analogy between the molecular motions and the eddy motions was pushed somewhat further by Prandtl in the introduction of the mixing length, which plays the same part in the eddy motions as the mean free path in the molecular motions. The isolation of small fluid masses and the mixing length itself actually exist only in a statistical sense. Prandtl's reasoning led to the result that the eddy viscosity was equal to ρl^2 times a function of the mean motion which for a parallel flow reduces to the transverse velocity gradient. The variation of the eddy viscosity from place to place is replaced by a variation of the mixing length l from place to place, which at first sight offers no advantage. But experiment shows that at large Reynolds Numbers the mixing length is practically independent of the speed and simple assumptions as to the spatial distribution give reasonably accurate results.

A further step was taken by von Kármán, who assumed that in the eddying motion the fluctuations at all points were similar, differing only in the linear scale and in the intensity of the fluctuations. This assumption led to an expression for the mixing length in terms of the mean flow and a universal constant. The consequences of the assumption have been worked out rigidly only for the case of parallel flow. The formulae for the skin-friction and for the velocity distribution obtained from Kármán's theory are in remarkably good agreement with experiment.

Until comparatively recently the only experimental information available on the characteristics of eddying flow consisted of measurements of mean values of speeds, pressures, or forces. A beginning has now been made on the experimental study of the fluctuations themselves by several independent methods. The use of the hot-wire anemometer has been studied at Delft, Gottingen, Teddington, California Institute of Technology, and at the National Bureau of Stand-

ards. Fage has applied the ultramicroscope with rotating objective. Townend has developed a technique using small sparks which give *hot-spots* that are rendered visible by the Schlieren method. Lindvall utilized the effect of the wind on a glow discharge between two electrodes. It seems certain that within a few years a considerable amount of information will be available to serve as a guide to the further development of the theory of eddying flow.

The expedition into the unknown begun by Dr. Zahm thirty years ago has thus been followed by others into the same regions, and we feel that we know something more about the territory. New interrelations have been discovered, and we feel that we have the key to the general geographical structure of the country beyond. It is astounding that the study of such a simple problem as the flow of air past a skin-friction plate should lead so far. But as the germ cell contains within itself the possibility of development into a rather intricate structure, so a single problem in aerodynamics contains within itself the possibility of answering many aerodynamic problems.

The account which has been given of studies in this particular section of the northern frontier could be repeated for other sections. One might, for example, describe the further development of another field of investigation to which Dr. Zahm contributed, the behavior of air at speeds near and above the speed of sound. Or one might describe the explorations, which are practically just beginning, on accelerated and unsteady motion, such as is associated, for example, with the pitching of an airplane wing. But we must now turn to the frontier on the east, bordering on the neighboring sciences.

Aerodynamics and hydrodynamics occupy much territory in common and are often regarded as essentially the same. It is true that the language and habits of thought are in large measure identical, but in the details of experimental technique there is sufficient difference that the experimenter in one field is not at home in the other without a season of apprenticeship. The theoretical workers intermingle more freely. Then too there are certain more or less isolated regions in both sciences, for example, the field of compressibility effects in aerodynamics and the fields of free-surface phenomena and of cavitation in hydrodynamics which are distinctive in character.

The indebtedness of the younger science, aerodynamics, to the older is very great. In water, events occur in slower tempo, a given flow-pattern occurring at about one-thirteenth the speed which would be necessary in air. The internal motions of water are readily made visible by small amounts of dye and the eye can in many cases readily

follow the motion. In air, on the other hand, it is necessary to use large volumes of smoke, to take photographs with a high speed motion-picture camera, and to view the pictures at a much reduced speed, if one wishes to observe the motion at reasonably large values of the Reynolds Number. Thus aerodynamics owes not only the underlying theoretical background, but also many of its mental pictures and experimental methods to hydrodynamics.

The benefits have not been altogether one-sided. The circulation theory of lift developed from the stimulus of an aerodynamic problem has found repeated application in hydrodynamic problems relating to hydrofoils, pump and turbine blades, etc. The boundary-layer theory is finding fruitful application in hydrodynamics as well as in aerodynamics. All that has been said about the transition from laminar to eddying flow and the effect of turbulence can be carried over word for word to the flow of water. Even the experimental techniques developed for studying fluctuations in eddying motion in air are beginning to be adapted to similar studies in water.

The sciences of meteorology and oceanography are coming under the influence of aerodynamic ways of thinking. I shall give only one or two illustrations. Atmospheric winds near the Rock of Gibraltar have been found hazardous to aircraft, especially when the wind blows from certain quarters. It occurred to someone to make a model of the rock, put it in a wind tunnel, and explore the flow in detail for several wind directions. The general features were checked by observations in natural winds at the full-scale rock.

About two years ago C. G. Rossby, Professor of Meteorology at the Massachusetts Institute of Technology, published a paper entitled *A generalization of the theory of the mixing length with applications to atmospheric and oceanic turbulence.* The title is self-explanatory. In this paper we find reference to boundary-layers from a 1000 feet to several miles in thickness. In a paper soon to be published by A. M. Kuethe of the Daniel Guggenheim Airship Institute at Akron, we may read of measurements of speed fluctuations within such a boundary-layer.

At the Fourth International Congress of Applied Mechanics, L. Prandtl presented a paper on the application of the laws of turbulent friction to atmospheric phenomena. He treated a number of special problems as well as the problem of the general atmospheric circulation on a rotating earth. Schlichting gave a theory of the stability of the laminar flow in a heated boundary layer and compared the results with measurements by Reichardt at Gottingen. These measurements

were made with a view to their application in meteorological problems.

The theory of heat transfer in forced convection has undergone a veritable revolution by the introduction of the boundary layer as a substitute for the hypothetical *film*. With the introduction of the concepts of laminar and eddying flow, and of transition as dependent on initial turbulence, many apparent contradictions have been explained. As indicated by Pohlhausen and Latzko, we can now proceed several steps beyond the convenient assumption of uniform mass flow of the fluid in studying the theory of forced convection. Thermal boundary layers are recognized as well as dynamic boundary layers. There is a mixing length involved in the transfer of heat as well as in the transfer of momentum and the two may or may not be the same. We introduce an eddy conductivity as well as an eddy viscosity and inquire as to their relationship.

The analogy between heat-transfer and skin-friction has been found very useful. Closer examination is revealing that the analogy has been perhaps pushed too far, ignoring the fact that pressure gradients affect the dynamic but not the thermal boundary layer and that momentum is a vector quantity whereas heat energy is a scalar. This interchange of information is proving beneficial to both sciences, the heat-transfer measurements throwing considerable light on the characteristics of eddying motion.

The study of evaporation and of diffusion has been facilitated by the introduction of the concepts of the laminar sub-layer and of mixing length. The experimental study of the relation between the mixing lengths involved in the transport of momentum, heat, water-vapor, solid particles, etc., promises to throw light on the mechanism of all.

Such are some of the contacts on the eastern frontier. While I do not claim that aerodynamics has always been benefactor and never beneficiary, I do think it is clear that the extension of the knowledge of how air moves near solid bodies immediately makes possible corresponding advances in the neighboring sciences.

We turn now to the western frontier, a region more familiar perhaps than those which we have been considering. Aerodynamics, of course, became of practical importance in the world with the development of aviation, and by far the larger share of aerodynamic research looks to aeronautics for its support. Until very recently, this territory was the only one with which there was efficient inter-communication. However, an adequate discussion of the interchange between aeronautics and aerodynamics, which after all *are* different fields of en-

deavor, would require much more space than can be given here and is perhaps superfluous for the purposes of this paper. The borderland here has long since ceased to be a frontier.

We shall accordingly turn to those regions which are still frontier in character, the first being the borderland between aerodynamics and the practical art of ventilation. The principal aerodynamic problems of ventilation may be briefly stated as (1) the design of fans, (2) the reduction of friction losses in ducts, and (3) the distribution of air from a small number of inlets throughout a large space. The design of fans involves the same fundamental principles as the design of airplane propellers, but a good airplane propeller is not a good fan. Nevertheless, in certain applications, such as in cooling towers used for cooling the water from condensers of steam-turbines, where large quantities of air are required to be delivered against comparatively small pressures, the simplicity and low initial cost of an inexpensive propeller mounted directly on the shaft of an electric motor led to several installations about five years ago. Soon after, aerodynamical principles were applied by one of the manufacturers, leading to a fan with comparatively large hub (one-third to one-half the diameter of of the fan) and with blades whose pitch increases toward the hub, with a very considerable improvement in efficiency. Very recently, Professor Marks and his colleagues at the Harvard Engineering School, have shown that an axial flow fan, with a diffusor and guide vanes, can be construoted to have an efficiency of 80 per cent.

There has also been much interest in the use of fans of this type for forced-draft installations, and for mine ventilation. Multi-stage fan wheels, with alternate rotating and stationary blades, have been proposed. There are, of course, disadvantages as well as advantages. The noise is much greater than for slower speed, multi-blade fans and the power-characteristic curve has some undesirable features. However, the application of aerodynamical knowledge to fan design is only in its infancy.

Information on air friction is immediately applicable in the design of ventilating ducts. However, the exigencies encountered in actual installations lead to many installations where the principal losses are due to obstructions or bends rather than to friction. When air flows around the usual pipe-bend, secondary motions are produced by the action of centrifugal force which destroy the approximately uniform flow. Large-scale turbulence is produced, with large energy losses associated with the dissipation of energy of this turbulence into heat. It has been found that these secondary motions may be largely elimi-

nated by using guide vanes arranged as a series of curved parallel blades which divide the airstream into a number of smaller streams which are separately guided around the bend. I believe these guide vanes were first developed at Göttingen in connection with the return-circuit wind tunnel, a set being installed at each bend. They have since found application not only in wind tunnel design, but in the design of ventilating ducts for large electrical generators. The theory of the action of these vanes is well worked out. The possibilities of their application have not been exhausted.

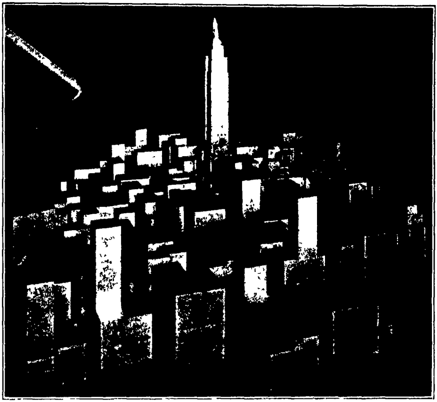
As an illustration of the reduction of losses due to obstructions, the ventilating ducts of the Holland vehicular tunnel may be mentioned. The exhaust duct is formed by the use of a false ceiling suspended from the top of the tunnel. In the original design the ceiling was to be suspended by cylindrical rods. A simple calculation showed that the resulting losses could be greatly minimized by a partial streamlining of the obstructions, accomplished by substituting flat strips edge on to the airstream for the cylinders.

The study of the distribution of air from fresh-air inlets is a virgin field. The investigation of turbulent mixing of jets by Tollmien and others should find immediate application.

Another frontier field is the application of aerodynamics to the design of windmills. Betz in Germany has taken the lead in the study of windmill wheels of few blades suitable for driving electric generators with only moderate gear ratios between the generator and windmill-wheel. His studies have illustrated the possibilities of theoretical computation of the performance and the value of wind-tunnel tests on models as a guide to further development. Two unconventional types, the Savonius rotor and the Flettner rotor, have received some study. In this field, aerodynamics has served to restrain somewhat the expectations of those enthusiasts who feel that because the wind is free, power from the wind should likewise be free. Simple principles show that the structure required to secure reasonable amounts of power from the wind is comparatively large. Initial cost, depreciation, and insurance against damage in high winds must receive careful consideration.

A field to which we have devoted some attention at the National Bureau of Standards is that of determining the wind pressure exerted on structures in wind storms. In the design of tall buildings, radio masts, water towers, chimneys, and similar structures, the allowance to be made for wind pressure is a matter of serious concern, first, in relation to the safety of the structure, and second, in relation to its

cost. To obtain information on wind pressure from observations on a building in a natural wind would require years of measurement and a statistical study of the results. The data so obtained would be limited to buildings of similar shape with a similar exposure. The only practicable procedure is to utilize the long series of observations of the Weather Bureau to forecast the probability of the occurrence of winds



6 —Models of Empire State Building and surrounding structures for wind-tunnel measurements

of specified speed. To obtain the pressure on the building, the relation between the pressure and the speed must be known. This relation may be determined by experiments on models in wind tunnels or by observations in natural winds. Each method has advantages and disadvantages. The principles of aerodynamics are invaluable in the interpretation of experiments by either method to avoid erroneous conclusions.

The use of both methods is illustrated in the publications of the

Bureau.[3] The wind-tunnel measurements on the model of the Empire State Building were undertaken with the expectation that measurements in natural winds would ultimately be made on the actual building for purposes of comparison. Completion of the project has been delayed by matters beyond our control. To illustrate the extent to which model experiments may be carried, there is shown in Fig. 6 a photograph of the model in the 10-foot wind tunnel with a crude but reasonably accurate representation of the territory for several blocks around. The scale is 1 to 250, the model being 5 feet high.

The results of these experiments and similar experiments abroad are slowly finding their way into building codes and in handbooks on design. The results are even having an influence in the design of houses, barns, and other farm structures as agricultural engineers recommend and insurance companies insist that houses be anchored to foundations, and that roofs be securely fastened to side walls to avoid failure as a result of suction and uplift produced by the wind. Perhaps more surprising is that at least one structure, the airship hangar at Akron, Ohio, has been especially designed to reduce the wind load, *streamlined* if you wish, on the basis of wind-tunnel tests.

As the final frontier region to be discussed, we come to the application of aerodynamical principles to the streamlining of automobiles and trains. When an automobile is driven along a level road, the power developed by the burning of the fuel is used in part to overcome the friction of the gears and bearings and of the tires on the road. The remainder of the power is used to overcome the resistance of the air. At speeds of 35 or 40 miles per hour the rolling resistance and air resistance are approximately equal and at higher speeds the air resistance becomes of the greatest importance.

If the air resistance of an automobile were due solely to air friction, the air resistance would be less than one-tenth that actually present in a typical modern automobile. It is not feasible to reduce the resistance of an actual automobile to this amount for practical reasons, but considerable improvement can be made. Halving the resistance is easily possible.

The possibility of improved fuel economy or higher speed through streamlining has been known for 10 years or more, and several experimental cars have been constructed. None of these cars has been commercially successful, and the so-called streamlining of present-day cars is essentially only a talking point. The accomplishments are trivial in comparison with the reduction that is easily possible. The

[3] Scientific Paper 523, Research Papers 221, 301, 545 and 637.

reason for the delay in introducing truly streamlined cars lies in the repugnance of the public to radical changes in appearance. Attempts are being made by manufacturers to make a gradual transition.

I do not wish to give the impression that there are no engineering problems involved in the change. There are many, but their discussion is out of place here. Their solution is in sight, if not already accomplished by some of the manufacturers.

The railroad groups are also much interested in streamlining. The new streamlined trains, which really owe much of their advantage to the reduction in weight made possible by the use of new materials and new methods of construction, have caught the public fancy. An experiment, which will be of more significance from the standpoint of streamlining alone, is the construction of a streamlined steam locomotive by one of the large manufacturers on the basis of wind-tunnel experiments.

In 1933, the National Bureau of Standards constructed for the Century of Progress Exposition in Chicago a small exhibition wind tunnel, in which were placed two models, one conventional and one streamlined, designed and constructed by W. H. Boyd of the aerodynamics section. Visitors were able to operate the wind tunnel and observe the very great difference in the air resistance of the two models. This exhibit aroused considerable interest and my colleague, R. H. Heald, has investigated not only the head-on air-resistance, but also other aerodynamic characteristics in side-winds. Mr. Heald has also made some studies of methods of representing the ground effect. These studies[3] illustrate the application of the experimental methods of aerodynamics to the streamlining problem.

In the application of aerodynamic methods to aeronautics, ventilation, windmill design, wind-pressure measurements, and streamlining, the contribution of the results obtained from basic research in aerodynamics may not be apparent to the casual observer. A little reflection, however, will show that the discovery, for example, of the very considerable effect of initial turbulence on many aerodynamic measurements must modify both the experimental procedure and the interpretation of the results. Similarly, with other advances in our knowledge of how air flows. Of course, engineers do not stop building airplanes, buildings, or automobiles until the new procedures are developed. The next generation of engineers will take the information which now seems new and use it, forgetting its origin. The present

[3] Research Papers 591, 748, and 749.

generation may continue to feel that basic research is useless, since it does not quickly answer their immediate problems.

And so we end the 1077th meeting. Thirty years from now, at the 1573rd meeting, perhaps someone will again review these frontiers.

BOTANY.—*New species and varieties of* Sedum *from China and Tibet.*[1] N. FRÖDERSTRÖM, Stockholm. (Communicated by E. P. KILLIP.)

The United States National Museum recently submitted to me a number of specimens of *Sedum* from China and Tibet, several of which prove to represent undescribed species and varieties. Most of these novelties were collected by Dr. Joseph F. Rock on his expeditions to the interior of China for the National Geographic Society and the Department of Agriculture.

Sedum aizoon L. var. **obovatifolium** Fröd., var. nov.

Kiangsi Province, Lu Shan; *A. N. Steward* 2602, July 20, 1922. (U. S. Nat. Herb. 1,345,868, type).

Planta robusta, 15–20 cm longa. Folia caulina confertim alterna, obovata, crebre dentata, obtusa, 25–35 mm longa. Inflorescentia densa, multiflora, lata, circ. 1.5×3.5 cm.

Probably but a stout local form of var. *latifolium Max.*, with exceedingly broad leaves. It seems to be nearest to a specimen from the Province of Kwei-chau, near Tschingdshen, about 1200 meters attitude (*Handel-Mzazetti* 10498 June 1917, Herb. Vienna and Froderstrom), but the leaves of that specimen are more spathulate-ovate.

Sedum concarpum Frod., sp. nov.

Yunnan, Likiang, China, alpine meadows, *Rock* 5434, 1922. (type in my herbarium; duplicate in U. S. Nat. Herb., no. 1,512,062).

Planta perennis, glabra, inferne decumbens et radicans, aphylla, in parte media rosulam foliorum et caulem floriferum, erectum, 8–9 cm longum, edens. Specimen nondum florens suberectum, multicaule, apice confertim foliosum. Folia caulium sterilium longe petiolata, fere orbicularia, apice obtusa et mamillata, basi breviter calcarata, 5–25 mm longa. Folia caulis floriferi subpetiolata, obovata, 5–10 mm longa. Inflorescentia (unius speciminis) denso corymbosa, involucrata. Flores anisopentameri, breviter (3–4 mm) pedicellati; bracteae foliis supremis similes. Sepala basi non producta, oblanceolata, prope basin leviter dilatata, apice obtusa vel subacuta, mamillata, aequalia, circ. 5 mm longa. Petala late lanceolata, sutura basali concreta, apice recurva (mitellata), 7–8 mm longa, lutea; stamina interpetala 5.5–6 mm longa, stamina epipetala circ. 2 mm supra basin inserta; antherae subovato-reniformes, circ. 1 mm longae. Squamae nect. late lineari-spathulatae, apice obtusae, circ. 1.1×0.4 mm crassae, in sicco rubrae. Carpella fere erecta, *e basi circ. 3 mm connata*, non gibbosa, satis longistyla, 5–6 mm longa;

[1] Received January 17, 1934.

folliculi 4–6-seminati, placentis rite ligamentosis. Semina subovoidea, breviter funiculata, glabra, circ. 1×0.4 mm.

Species distincta, ad *S. chauveaudi* Hamet et quodammodo ad *S. leucocarpum* Franch. spectans, folia autem petiolata laminis suborbicularibus, sepala aequalia et carpella ad medium connata.

Sedum jupaernse Frod., sp. nov.

Eastern Tibet, Jupar Range: among rocks on Totuch nira, north of Ba Valley, 13900 ft. *Rock* 14365, July 1926 (U. S. Nat. Herb. 1,509,461, type).
Planta perennis, glabra, monoica?: flores masculos et femineos separatim ferens (an specimen gemellum e duabus plantis dioicis compositum?). Radices plures, percrassae, perpendiculares, usque ad 25 cm longae. Caudex epigaeus pluries divisus, caespitem densum, fere orbicularem formans, basi squamis desiccatis late triangularibus obtusisque cinctus. Caules desiccati valde numerosi, graciles, caules novos fere aequantes. Caules steriles vel nondum florentes erecti vel dispersi, apice confertim foliosi, 1.5–3 cm longi. Caules floriferi numerosi, flabelliformiter dispersi, 2–4 cm longi. Folia omnia lineari-lanceolata, basi non producta, integerrima, apiculata et acuta, 3–5 mm longa. Inflorescentia conferta, pauciflora; bracteae lineares, acutae, 2–2.5 mm longae. Flores omnes pentameri, breviter pedicellati. *Flores masculi:* Sepala semioblonga, subobtusa, 1.5–2 mm longa. Petala subobovata, basi leviter contracta, apice obtusa et submucronata, circ. 2 5 mm longa, in sicco lutea; stamina omnia petalis fere dimidio breviora, 1.5–1.8 mm longa, epipetala 0.5 mm supra basin inserta; antherae late reniformes Squamae nect. quadratae, apice profunde emarginatae, circ. 0.9×1 mm in sicco luteae. Carpella minuta, late ovata, brevistyla, sterilia, vix 1 mm longa. *Flores feminei:* Sepala ut supra. Petala late ovata, infra medium parum contracta, apice obtusa, 2.5–3 mm longa, in sicco pallide lutea; *staminodia* interpetala circ. 1 mm longa, apice obtusa, epipetala 0.5 mm supra basin inserta, deinde 0.5 mm longa, apice obtusa. Squamae nect. quadratae, apice leviter emarginatae, circ 0.75×0.80 mm, in sicco luteae. Carpella suberecta, longitudine parum inaequalia, subovoidea, brevistyla, 2.5–3 mm longa; folliculi *1–3-seminati*, placentis rite ligamentosis. Semina solitaria subovoidea, utrinque alata, glabra, 2×0.7 mm; semina alia ovoidea, 1×0.35 mm.

Species vero peculiaris, habitu ad formas chinenses *Sedi quadrifidi Pall.* maxime spectans. Ab omnibus autem differt: flores monoici?, petala lata, stamina floris masculi petalis breviora, flores feminei staminodia ferentes et eorum carpella pauciseminata.

Sedum likiangense Fröd., sp. nov.

Yunnan, Likiang, *Rock* 4991, 1922 (U. S. Nat. Herb. 1,512,574, type).
Planta perennis, glabra, dioica. Radix simplex, gracilis, circ. 10 cm longa. Caudex epigaeus multoties divisus, densissime caespitosus, caespitem fere orbicularem, circ. 10 cm diametro, formans. Squamae basales? Caules desiccati numerosi, graciles, breves. Caules steriles vel nondum florentes stellatim dispersi, apice dense foliosi, 2–3 cm longi. Caules floriferi suberecti vel dispersi, numerosi, 2–3.5 cm longi. Folia omnia lineari-lanceolata, basi breviter calcarata, apiculata et acutissima, 4–7 mm longa. Inflorescentia uniflora vel conferte pauciflora; bracteae lineares, acutae, 3–3.5 mm longae. Flores omnes feminei, tetrameri, breviter pedicellati. Calycis fundus circ.

1 mm altus, sepala semioblongo-triangularis, acuta, 3 mm longa. Petala late oblonga, basi breviter obtuseque producta, apice obtusa, 3–4 mm longa, in sicco rubra; staminum nullum vestigium. Squamae nect. trapezoideae, latiores quam longae, apice planae et emarginatae, 0.6×0.8–1 mm, in sicco rubrae. Carpella suberecta, subovoidea, brevistyla, stylis recurvis, basi circ. 0.5 mm connata, 4–4.5 mm longa; folliculi multiseminati, centis rite ligamentosis. Semina ovoidea, utrinque alata, glabra, circ. 2×0.75 mm.

Habitu valde ad *Sedum juparense* Frod. spectans, itaque e vicinitate *Sedi quadrifidi Pall.*, a quo tamen differt habitu caespitosissimo, foliis acutissimis et inflorescentia vulgo uniflora.

Sedum megalanthum Fröd , sp nov.

Type sheets: ♂ S. W. Szechuan, Mt. Konka, Risonquemba, Konkaling, 3960–5335 m; cushion plant, flowers red; *Rock* 16415, June 1928. ♀ Yunnan, eastern slopes of Likiang Snow Range, Yangtze watershed, 14500–15000 ft; *Rock* 9848, 1923–24 (types in my herbarium; duplicates in U. S. Nat. Herb., nos. 1,333,815 and 1,512,070).

Co-sheets: ♂ Yunnan, Yangtze watershed, western slopes of Likiang Snow Range, 12000–13000 ft; flowers carmine red; *Rock* 4346, May–June 1922. ♂ Yunnan, between Likiang, Tungshan, Tuinaoko, and Tsilikiang, dry Yangtze drainage basin, 14500 ft; flowers red; *Rock* 9780, May 1923. ♂ Muli, S. W. Szechuan, Mt. Mitzuga, west of Muli Gomba, 3050–4875 m; rock plant, flowers purplish red; *Rock* 16596, June 1928. ♂ Muli, S. W. Szechuan, Mt. Siga, northeast of Kulu, 4770–4900 m; flowers red; *Rock* 17923, June 1929.

Planta dioica, perennis, 15–20 cm longa. Caudex robustus, erectus, supra terram brevis et latus, paulum divisus, apice squamis siccis, late triangularibus acutisque cinctus. Caules desiccati plures, nigricantes, robusti, 10–15 cm longi. Caules steriles vel nondum florentes erecti, robusti, 15–17 cm longi, apice convertim foliosi, eorum folia media spathulato-ovata, subacuta, 25–30 mm longa. Caules floriferi numerosi vel pauci, erecti vel flabellatim dispersi, satis robusti, 10-20 cm longi. Folia media et superna subpetiolata, laminis ovatis vel suborbicularibus, margine integris vel undulatis vel crenatis, apice apiculato-obtusis, 6–25 mm longa. Inflorescentia dense corymbosa, lata, 10–15–flora, foliis supremis involucrata; bracteae?; pedicelli sparse papillosi, calyce aequales vel longiores. Flores pentameri, magni. *Flores masculi:* Sepala late linearia vel lanceolata, apice obtusa, 2–2.5 mm longa. Petala pseudounguiculata, usque ad basin libera, oblanceolata vel parum latiora, integra, apice obtusa, 7–7.5 mm longa, in sicco lucide rosea. Stamina omnia fere aequilonga, petala parum superantia, epipetala circ. 2.5 mm supra basin inserta; antherae ovatoreniformes, circ. 1 mm longae. Squamae nect. rectangulares, basi parum dilatatae, apice divisae vel profunde emarginatae, circ. 1.5×0.45 mm. Carpella sterilia, brevistyla, lanceolata, 3–3.5 mm longa. *Flores feminei:* Sepala e basi dilatata lineari-lanceolata, apice subobtusa, circ. 3 mm longa. Petala basi parum dilatata, oblanceolata, apice obtusa, 5–5.5 mm longa, in sicco lutescentia; stamina nulla. Squamae nect. quadratae, crassae, apice planae et leviter emarginatae, circ. 1×1 mm. Carpella erecta, brevistyla, late lanceolata, basin versus parum attentuata, 9–10 mm longa, in sicco rubra; folliculi multiseminati, placentis rite ligamentosis. Semina subovoidea, glabra, utrinque alata, apice elongata, 1.5–2 mm longa.

Species habitu *Sedo rotundato* Hemsl. valde similis, differt autem floribus majoribus, petalis pseudounguiculatis, et staminibus alte insertis.

Sedum yunnanense var **muliense** Fröd., var. nov.

Muli, Mt. Siga, northeast of Kulu, 4300 m; flowers purplish: *Rock* 17915, June 1929 (type in my herbarium; duplicate in U. S. Nat. Herb., no. 1,510,322).

Caules floriferi suberecti, 50–60 cm longi; folia quaternata vel superne ternata, integra vel undulata, obovata vel lanceolata, obtusa, 12–30 mm longa; inflorescentia laxe thyrsoidea, e cymulis paucifloris composita; flores masculi, 5–6–meri, petala subovata, 3 mm longa.

Ad var. *forrestii* Hamet spectans, sed habitu, foliorum forma et inflorescentia satis distincta.

Sedum yunnanense Franch. var. **papillocarpum** Frod var. nov.

Yunnan, prope Chungtien, circ. 3600 m *C. Schneider* 3025, Sept. 1914, (U. S. Nat. Herb., no. 776,718, type).

Planta "20-35 cm" longa, quinquecaulis; folia ternata, oblonga, dentata vel sublobata, acuta, 10–30 mm longa. Flores feminei pro specie magni, pentameri; carpella turgida, papillis altis dense instructa, stylis longis recurvisque, 5 mm longa; semina lanceolata, glabra, 1.9×0.45 mm.

Var. *forrestii* Hamet proxima, folia autem ternata, carpella magna, denso papillosa, et semina lanceolata.

♀ **Sedum yunnanense** var. **rotundifolium** Fród , var. nov.

Yunnan, Tungshan, Yangtze drainage basin, east of Likiang; flowers yellowish; *Rock* 10517, 1923 (type in my herbarium; duplicate in U. S. Nat. Herb., no. 1,512,078).

Caulis solitarius erectus, 45 cm longus; folia verisimiliter opposita, denticulata, orbicularia, obtusissima, 20-40 mm longa et lata; inflorescentia paniculata, 13 cm. longa, e cymulis longe pedunculatis, paucifloris composita; flores feminei, 4–5–meri, carpella 3 mm longa stylis recurvis.

Between var. *henryi* Hamet and *Sedum sinicum* Diels (which is probably but a variety of *Sedum yunnanense*), but the leaves are decidedly orbicular and very blunt, and the inflorescence elongate, almost thyrsoid, as in the head species.

♀ **Sedum yunnanense** var. **strictum** Fród., var. nov.

Muli, Mountains of Kulu, 4150 m; flowers red; *Rock* 18214, Sept. 1929 (type in my herbarium, duplicate in U. S. Nat. Herb. no. 1,510,623).

Caules stricte erecti, usque ad 30 cm longi; folia ovata vel lanceolata, sublobata, apice obtusa, inferiora circ. 10 mm longa, media 15–20 mm. superiora ignota; inflorescentia thyrsoidea, angusta, interrupta, 12 cm longa, e cymulis parvis, confertis composita, flores feminei, 5–6–meri, sepalis petalisque fere aequilongis, 1.2–1.4 mm; squamae nect. longiores quam latae; circ. 0.8×0.6 mm, apice obtusae, in sicco rubrae; carpella basi lata, turgida, stylis longis recurvisque, 3–3.5 mm longa; semina lanceolata, glabra, utrinque breviter alata, circ. 1.2×0.4 mm.

Planta unica defecta, itaque non satis dignoscenda. Ad var. *forresti* Hamet spectans, sed fortasse species distincta ob habitum et structuram floralem.

PALEOBOTANY.—*Fossil plants from the Malacatos Valley in Southern Ecuador.*[1] EDWARD W. BERRY, The Johns Hopkins University.

In my discussion of the Flora of the Loja Basin in Southern Ecuador[2] I mentioned the possible presence of late Tertiary continental deposits around the source of the Rio Catamayo in southern Ecuador near Malacatos (Valladolid) and Vilcabamba south of the Sierra Cajanuma, which separates the headwaters of the Rio Zamora, an Amazon tributary, from those of the Rio Catamayo, a Pacific stream. This suggestion was based on Wolf's early work.[3] Recently through the kindness of Professor Clodoveo Carrión of Loja I have received material from two localities in the Valley of Rio Malacatos as the Catamayo is here called, one 2 km. north and the other 1 km. south of the town of Malacatos.

The material from the former, the exact locality being along the motor road under construction between Loja and Malacatos, consists of but 4 specimens containing well preserved foliage in a fine grained silt or tuff, whitish in color with some yellowish iron stains, and of a sort which is identical with some of the lithologic facies of the plant-bearing material around Loja. Four clearly recognized species are represented. These are the terminal part of a pinnule of the fern *Goniopteris cochabambensis* Berry, a leaf of the polygonaceous genus *Ruprechtia* identical with *Ruprechtia braunii* described by Engelhardt from the Pliocene tuff at Potosí, Bolivia , a leaflet of *Cassia linearifolia* described originally from Loja by Engelhardt, and a leaflet representing a new species of *Pithecolobium* which may be described as follows:

Pithecolobium ecuadorensis n. sp.

Leaflets small, sessile, inequilateral, elongate elliptical in outline, somewhat coriaceous in texture, with entire margins. Length about 2.6 centimeters. Maximum width 10 to 11 millimeters. The tip is somewhat narrowly rounded and except for its asymmetric attitude is practically equilateral. The base is very inequilateral, being ascending on one side and truncately rounded on the other. Midvein stout and curved. Secondaries well marked; there are 6 or 7 on the concave side of the midvein and 7 or 8 on the convex

[1] Received December 10, 1934.

[2] BERRY, EDWARD W. Johns Hopkins University Studies in Geology 10: 79–134, pl. 1–6. 1929

[3] WOLF, T. & RATH, G. VON. Zeit. Deutsch Geol. Gesell. 28. 392. 1876.

side; except at the base they are regularly spaced, diverging from the midvein at angles in excess of 45 degrees and camptodrome; toward the base they are more crowded, those on the concave side being straighter and diverging at a more acute angle, those on the convex side are curved and diverge at a wider angle. The tertiaries are thin but distinct and comprise 1 or more from the midvein between adjacent secondaries connected with the latter by more or less percurrent nervilles.

This is a very characteristic form. Among previously described fossil species it is very close to *P. oxfordensis* Berry of the lower Eocene Wilcox group of southeastern North America. Among existing forms it is identical with *P. gracilliflorum* Blake of Central America, although I have not compared the fossil with all of the existing species and it may well be that there are upper Amazon species equally similar to the present fossil form, in fact there is a great similarity among the leaflets of all of the existing species.

The genus *Pithecolobium*, or *Pithecellobium* as Martius spelt it, contains over 100 existing tropical species, three-fourths of which are American where they range from the Florida Keys to northern Argentina. In recent years 14 fossil species, all American, have been described. The oldest comprise 4 forms from the lower Eocene of southeastern North America. There is an Oligocene species in the same region; Miocene species in Porto Rico, the Dominican Republic, Trinidad and Colombia; Pliocene species in Bolivia and eastern Peru; and a Pleistocene form in Trinidad.

The second locality is 1 km. south of Malacatos on the west side of an irrigation ditch known as "La toma de agua del Dr. Aguierre." The matrix is a rather dense, bluish, secondarily iron-stained clay, considerably deformed and consequently hackly, but whether due to tectonic forces or slumping can not be stated. This clay has failed to yield any traces of dicotyledonous leaves, but is packed with the pinnules of the fern *Elaphoglossum carrioni* Berry already known in abundance from several localities around Loja, and from its method of occurrence obviously a compound and not a simple fronded type. In addition there are several specimens of *Goniopteris cochabambensis* Berry and *Poacites magnus* Englehardt, the last a large Chusquea-like grass.

The present collection also contains several specimens of the fish *Carrionellus diu-mortuus* Ivor White from the nudo of Cajanuma at the southern end of the Loja Basin.

All of these forms, with the exception of the new species of *Pithecolobium* and the *Ruprechtia*, are common elements in the flora of the Loja Basin, and the deposits of these inter-montane basins in the Ecuadorian Andes are evidently all of approximately the same age.

Recently I described several occurrences of fresh water mollusks and land plants from the Cuenca Basin in Ecuador.[4] These came from near the town of Biblian in the Azogues valley, so that there is now definite evidence of the presence of similar late Tertiary continental deposits of probably fluviatile palustrine and lacustrine character, and possibly eolian as well, largely made up of volcanic ash, over a north and south distance of upwards of 150 miles. It seems very probable that similar fossiliferous deposits of approximately the same age may be expected in the other inter-Andean basins north of the Cuenca Basin.

Malacatos has a present altitude of 5187 feet which is from 1800 to 2100 ft. lower than the plant bearing outcrops in the Loja Basin and about 2800 ft. lower than the similar outcrops in the Cuenca Basin. At the present time the climate at Loja and Cuenca is arid temperate, while that at Malacatos is subtropical. In all cases the fossil plants are mesophytic tropical types and the evidence is clear that there has been a considerable amount of vertical uplift since these deposits were laid down. Whether or not their present altitude is to be ascribed to differential uplift or to deposition at originally different levels can not be stated, although it seems clear that all occurred at the same physiographic stage in the geological history of the region.

[4] BERRY, EDWARD W. This JOURNAL 24 184–186. 1934.

ZOOLOGY.—*Life history of* Longistriata musculi, *a nematode parasitic in mice.*[1]

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This paper contains a brief account and discussion of the life history of a trichostrongyle, *Longistriata musculi*, parasitic in the intestine of the mouse, *Mus musculus*, and readily reared to fertile maturity in white mice. In addition to the conventional account of the life history, the writers have included in this paper information on the course of infection, including a consideration of such problems as the

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egg production, susceptibility of the host to reinfection following the apparent termination of egg production, and a discussion of the results obtained.

METHODS USED

Live infested mice were shipped to Washington, D. C., from Jeanerette, Louisiana. The feces of these animals were mixed with moist animal charcoal, and the mixture was placed on moist filter paper in covered petri dishes. The infective larvae migrated to the edges of the filter paper which were turned up at right angles to the bottom of the glass dishes. The larvae were readily detected along the edges of the filter paper, usually in clusters, adhering to the paper by their tails and waving the anterior portions of their body. By cutting off portions of the filter paper on which larvae had accumulated and placing the bits of paper in a glass dish containing a small quantity of water, the larvae could be counted readily when comparatively few were present. When large numbers of larvae were obtained in this manner they were counted by the dilution method.

In studying the development of the free-living stages, the writers isolated single eggs with the aid of a capillary pipette, and placed each egg in a drop of very dilute fecal emulsion in a small stender dish having an inside diameter of 20 mm. The dishes were kept in a moist glass chamber containing several layers of wet filter paper. The individual dishes were taken out of the moist chamber as often as necessary and examined microscopically to ascertain the progress in development.

The individual mice were kept and fed in large battery jars, a folded paper hand towel being used as bedding. The animals were fed on oats, and this was supplemented by cabbage twice a week. The feces, bedding and remnants of food particles were removed daily, and the jars were scalded with hot water and then dried. This procedure precluded the possibility of extraneous infection.

In experimental percutaneous infections, the infective larvae in a small quantity of water were placed on various portions of the skin of white mice anesthetized with ether, the mice being kept under anesthesia until the water containing the larvae had evaporated. The larvae were placed on portions of the skin from which the hair had been clipped or shaved. Larvae were introduced into the mouth in a small quantity of water with the aid of a pipette. The lungs, liver, portions of the wall of the alimentary canal and other organs were examined post mortem for larvae with the aid of the Baermann ap-

paratus and in press preparations. The heart's blood and other fluids of the body were removed to glass slides with the aid of capillary pipettes, after being diluted with physiologic saline and examined for larvae. Mature worms were obtained from the lumen of the intestine by slitting the wall of this organ in a glass dish containing physiologic saline and removing the worms from the solution as well as from the lining of the intestine.

The Stoll dilution technique was used in making egg counts. The total fecal output for 24 hours of the mice involved in this investigation in no case exceeded 0.22 gms., and usually weighed about 0.2 gms.; in a few cases the weight was as low as 0.05 gms. In making fecal dilutions for the counts, practically the entire fecal sample was used in nearly all cases. For the purpose of ascertaining the presence of eggs, the salt flotation technique was used.

PREPARASITIC DEVELOPMENT

The segmented eggs eliminated with the feces of infested mice hatched in about 24 hours in laboratory cultures maintained at a temperature of 24°C. The newly hatched larva feeds almost continuously and grows considerably during the feeding period which lasts about 4 days during the summer months. The molting larva is encased in a sheath, the cuticle of the first-stage larva, which apparently is not discarded in water. On solid culture media, consisting of moist animal charcoal to which mouse feces have been added, the sheath is discarded. The exsheathed larva is infective to mice, and is morphologically and physiologically identical with the third-stage larva of other strongyles; as will be shown in connection with its morphology and in the discussion, it should be regarded as corresponding to a third-stage rather than a second-stage larva, on the assumption that the first molt has been suppressed.

EXPERIMENTAL INFECTIONS THROUGH THE MOUTH

Experiment 1. Each of two mice (nos. 1 and 2) was fed 500 infective larvae. Five days after the experimental feeding, the feces of these mice were still free of eggs; 7 days after the experimental feeding a few eggs of *L. musculi* were found in the feces of mouse no. 1 and numerous eggs were found in the feces of mouse no. 2.

Experiment 2. Mouse no. 3 was given 6 feedings of 100 larvae each as follows: May 23, 1 P.M.; May 24, 9 A.M.; May 25, 9 A.M., 4 P.M. and 9 P.M.; May 26, 9 A.M. The mouse was killed on May 26,

11:30 A.M., 70½ hours after the initial feeding and 2½ hours after the last feeding. Post-mortem examination for worms yielded the following results:

Thirty-five larvae showing no increase in size and no progress in development beyond those of the infective larvae, were found in the stomach; in the small intestine there were present 143 larvae, some showing no evidence of growth beyond that of the infective larva, others showing an increase in size, and some showing early signs of the first parasitic molt, in addition to 140 preadult worms corresponding morphologically to fourth-stage larvae of other strongyles; of these worms 63 were males and 77 were females. The large intestine contained 9 living infective larvae. The liver, lungs and heart's blood were examined for larvae with negative results.

Experiment 3. Mouse no. 4 was given 2 feedings of 100 larvae each on May 29, 2:30 P.M., and May 31, 2:30 P.M. This mouse died some time between 4:30 P.M., May 31, and 9 A.M., June 1. Post-mortem examination revealed 30 larvae in the stomach showing no evidence of growth beyond that attained by the infective larvae, 80 worms in the small intestine, of which 49 (18 males and 31 females) were in the preadult stage and 31 were in the infective stage. No larvae were found in the liver and lungs.

Experiment 4. Mouse no. 5 was given 200 infective larvae on June 2. On June 7, 5 days after experimental feeding, this mouse was killed and examined for evidence of infestation with the following results:

The small intestine contained 32 worms of which 22 (15 males and 7 females) were in the preadult stage, but were already in the third or final ecdysis, while the remaining 10 worms (6 males and 4 females) were in the final, or adult, stage, having discarded the sheath of the last molt before the host animal was killed. The females did not as yet contain eggs in the uteri. No worms were found elsewhere in the alimentary canal. The lungs were free of worms.

It is evident from these data that the entry of *Longistriata musculi* larvae through the oral route not only leads to the development of these worms to fertile maturity, as evidenced by the appearance of eggs in the feces of the experimental host animal on the seventh day following the administration of the larvae (experiment 1), but that the entire development takes place in the small intestine, as shown in experiments 2, 3 and 4. All the developmental stages, beginning with those indistinguishable from the infective stage, through the various growth changes in that stage, the first parasitic ecdysis, the preadult

stage, which follows the casting off of the sheath, growth changes during the preadult stage, the second parasitic ecdysis, and adult or final stage which follows the final exsheathing, were found in the small intestine. No evidence was found of a migration of the larvae from the alimentary canal to the liver or lungs. *Longistriata musculi* is, therefore, capable of achieving its full development in the intestine following the ingestion of the infective larvae. The latter reach the stomach first, and in this organ some of them, and perhaps all of them, linger for a while and then pass into the small intestine where sexual maturity is attained following growth and development accompanied by 2 molts. Preadult worms were already present in experimentally infected mice about 48 hours after experimental feeding, and adult worms, not yet fully grown, were found 5 days after experimental feeding. The entire parasitic development, commencing with the ingestion of infective larvae and ending in egg-laying maturity, was completed in 7 days.

EXPERIMENTAL INFECTIONS THROUGH THE SKIN

Mice were exposed to experimental infections through the skin with a view to (1) determining whether the skin is a suitable portal of entry of *Longistriata musculi* larvae into the body of the rodent host; (2) tracing the course of migration of the parasites from the skin to the small intestine; and (3) ascertaining the precise locations in the body where the development of the larvae is resumed after being suspended following the preparasitic molt. The results of experimental percutaneous infections involving 17 mice, examined at various intervals following the exposure of the skin to infective larvae, the intervals ranging from ½ hour to 7 days after infection and corresponding to the periods during which migration, growth and development take place, are summarized in table 1.

An examination of the data presented in table 1 shows among other things (1) that the larvae which were placed on the intact skin actually penetrated this tissue and that some of them were still present in the skin layers 4 hours after having been placed on the surface; (2) that at least one larva was found in the stomach as early as one hour after the exposure of the skin to larvae and that fairly large numbers of larvae were found in the stomach 3, 4½ and 6 hours, respectively, following the placing of the larvae on the skin; (3) that the larvae were found in the stomach before they were seen in the small intestine or that many more were present in the stomach than in the small intestine up to 6 hours following skin infection; (4) that

some larvae reached the small intestine as early as 3 hours after they had been placed on the skin and that 10 hours after skin exposure the number of larvae which were present in the intestine was in excess of those present in the stomach; (5) that 24 hours following exposure of the skin to larvae, the latter were localized exclusively in the small intestine, in which organ they continued their development; (6) that preadult worms were present in the intestine about 48 hours

TABLE 1.—RESULTS OF PERCUTANEOUS INFECTIONS OF 17 MICE

Mouse Number	No. of larvae placed on skin	Duration of experiment	Post-mortem results'
6	150	1 hour	20 larvae in skin and 1 in stomach, all in infective stage
7	500	2 hours	24 larvae in skin
8	800[a]	1–3 hours	26 larvae in stomach and 5 in intestine, all in infective stage
9	600[b]	½–3½ hours	22 larvae in skin; all in infective stage
10	800[c]	½–4 hours	1 larva in lungs, 2 in esophagus, 15 in stomach, 7 in intestine, all in infective stage
11	1,000	4 hours	4 larvae in skin, all in infective stage
12	1,000	4 hours	Negative
13	1,000	4½ hours	6 larvae in stomach; all in infective stage
14	1,000	6 hours	76 larvae in stomach, all in infective stage
15	150	10 hours	11 larvae in stomach, 27 in intestine, all in infective stage
16	1,000	10 hours	34 larvae in stomach, 94 larvae in intestine; all in infective stage
17	1,000	24 hours	228 infective larvae
18	1,000	24 hours	109 larvae in intestine, stage not noted
19	1,000	48 hours	103 preadult worms in intestine
20	1,000	72 hours	72 preadult worms in intestine
21	200	120 hours	38 worms in intestine, 11 males and 11 females in final stage, and 9 males and 7 females in preadult stage
22	500	7 days	86 fully developed worms (41 males and 45 females in intestine)

[a] Larvae placed on skin as follows 400 at 11 A M , 200 at noon, 200 at 1 P M Mouse killed at 2 P M

[b] Four consecutive infections of 150 larvae each at intervals of one hour Mouse killed 30 minutes after final exposure to infections

[c] Four consecutive infections of 200 larvae each at one-hour intervals Mouse killed 30 minutes after final exposure to infection

after skin exposure; (7) and that 5 days after experimental infection the majority of the worms were already in the final (adult) stage, and that 7 days after infection all the worms present in the intestine had attained the adult stage.

Although the data on mouse no. 10 appear to indicate that the path followed by the larvae from the skin to the intestine was the route usually followed by skin-penetrating nematodes, namely from skin to the lungs by way of the circulation and from the lungs to the intestine by upward migration in the bronchioles, bronchi and trachea, and thence back to the alimentary canal, the post-mortem data on the re-

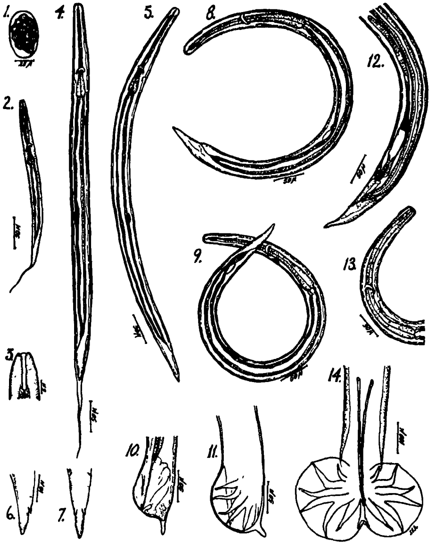

Fig. 1–14.—Stages in the development of *Longistriata musculi*. Fig. 1.—Egg from fresh feces. Fig. 2.—Newly hatched larva. Fig. 3.—Anterior end of preinfective larva. Fig. 4.—Preinfective molting larva. Fig. 5.—Infective larva. Fig. 6.—Tail of infective larva (lateral view). Fig. 7.—Tail of infective larva (ventral view). Fig. 8.—Male larva showing the beginning of the first parasitic molt. Fig. 9.—Female larva showing the beginning of the first parasitic molt. Fig. 10.—Posterior portion of preadult male, 3 days after experimental infection. Fig. 11.—Posterior portion of preadult male in the final molt, 5 days after experimental infection. Fig. 12.—Posterior portion of preadult female. Fig. 13.—Anterior portion of preadult male. Fig. 14.—Bursa of young adult male, 5 days after experimental infection.

maining mice given in table 1 do not support this assumption, despite the evidence that the larvae reached the stomach before they appeared in the intestine in some of the experimental infections. Careful examination of the hearts' blood, the fluid of the peritoneal and thoracic cavities, the lymph glands, lungs, liver, spleen, pancreas, kidneys, and other organs and tissues in which larvae might be present if they were carried in the circulation, yielded consistently negative results in all cases in which such examinations were made, and practically all the mice involved in this investigation were examined with a view to determining the probable path of migration. Aside from this negative helminthological evidence, no lesions suggestive of lung invasion by nematode larvae were noted in any of the mice involved in this investigation. There was a complete absence of petechial and ecchymotic spots in the lungs, lesions usually associated with the invasion of the lungs by nematode larvae.

While the possibility of a direct migration to the alimentary canal through the tissues and cavities of the body must be considered as an alternative to migration through the lungs, the available evidence, especially the failure to find larvae in press preparations of the wall of the stomach and small intestine, lends no support to this possible migratory route. The question of the path followed by the larvae of *Longistriata* from the skin to the alimentary canal must be left open for the time being.

MORPHOLOGICAL ASPECTS OF DEVELOPMENT

The outstanding morphological features in the development of *L. musculi* are shown in the illustrations (figs. 1–14). The brief descriptions which follow help to clarify the illustrations.

Egg.—The egg (fig. 1) has a morphology characteristic of other trichostrongyle eggs; it is 61 to 68μ long by about 38μ wide, elliptical in shape, thin shelled, and segmented when found in fairly fresh feces.

Preinfective larva.—This larva (fig. 2) resembles those of other members of the family Trichostrongylidae. It is slender, cylindrical, tapering slightly anteriorly and more so posteriorly, and is provided with a long filamentous tail. The newly hatched larva is from about 296 to 311μ long by 17μ wide. The mouth opening leads into a cylindrical buccal cavity or pharynx (fig. 3) about 15μ long; the esophagus is characteristically rhabditiform, 91 to 95μ long, its bulb being provided with the usual Y-shaped valve; the intestine, about 120μ long is followed by a short rectum. The nerve ring is about 65 to 79μ, and

the genital primordium 152 to 167μ, respectively, from the anterior extremity. The tail is 60 to 68μ long.

The first preinfective larva grows considerably, attaining a length of 750μ, including the long filamentous tail. At this stage the larva is already ensheathed (fig. 4), the sheath inclosing a short-tailed infective larva.

Infective larva.—Though the infective larva undergoes only one molt, it must be considered as the homologue of the third-stage infective larva of other Trichostrongylidae since it presents morphological features typical of third-stage larvae. In the life cycle of *L. musculi* the molt corresponding to the first molt of other strongyles is evidently suppressed, the molt which takes place being the homologue of the usual second molt since it gives rise to an infective larva.

The infective larva (fig. 5) has the general features of the first-stage larva, differing from the latter principally in the structure of the esophagus and the shape of the tail. It is 610 to 677μ long and 26μ wide. The mouth is closed and leads into a buccal cavity or pharynx about 8μ long, which in turn communicates with a club-shaped esophagus about 163 to 171μ long; the intestine, about 425μ long, is followed by a rectum about 38μ long. The nerve ring, excretory pore and genital primordium are 110μ, 121 to 129μ, and 350 to 587μ, respectively, from the anterior extremity. The tail (figs. 6 and 7) is relatively short and blunt, from 47 to 57μ long, and is provided with two subventral processes located about 10μ from its tip.

Growth of infective larva in host.—In the intestine of the host the third-stage larva increases gradually in length and in width, attaining a size of 750μ by 34μ about 24 hours after experimental infection. Evidence of the first parasitic molt was found in two larvae 725μ long by 26μ wide and 750μ long by 34μ wide, respectively, the smaller worm (fig. 8) being recognizable as a male and the larger worm (fig. 9) as a female, by the respective positions of the genital primordia, that of the female having migrated posteriorly. In the preadult stage the vulva and vagina are seen in the relative position taken up by this genital primordium.

Preadult stage.—The larvae grow considerably during this stage, and show unmistakable sex differentiation. The anterior portion of the larva (fig. 13) shows a small provisional buccal capsule and a cuticular inflation around the head extending to a distance of about 25μ posteriorly. The posterior portion of the male (fig. 10) is distended; the swollen portion forms the bursa and the indistinct folds are the precursors of the bursal rays. In the female (fig. 12) the vulva

and other accessory parts of the reproductive system, as well as the ovary, are well developed about 3 days after experimental infection. At this time the males are 1.38 to slightly over 2 mm. long by 40 to 77μ wide in the swollen posterior portion, and the females are 1.8 to 2.35 mm. long by 50 to 75μ wide. Five days after experimental infection, the preadult worms, already showing evidence of the last ecdysis, are about 3.2 to 3.4 mm. long by 78 to 83μ wide. The rays of the male bursa are fully developed in the worms undergoing the final molt (fig. 11). In a small series of measurements involving only 2 worms of each sex, the males were 3.11 to 3.4 mm. long by 78 to 93μ wide and the females were 3.2 mm. long by 76 to 83μ wide.

Young adult stage.—In young fifth-stage worms, 5 days after experimental infection, the largest females measured 5.1 mm., whereas the largest males were only 4.1 mm. long. In the male at this stage (fig. 14) the bursa and spicules have the characteristic morphology of those of the fully developed adult worm.

DISCUSSION OF LIFE HISTORY

The life history of *Longistriata musculi* presents several interesting features in its development, namely, (1) a deviation from the usual four molts which characterize the development of nematodes generally; (2) the adaptation of the infective larvae to entrance into the host through the mouth and through the skin, either avenue of infection leading to development of the worms to fertile maturity; (3) the migratory course of the larvae following skin penetration, in which the usual route through the lungs is apparently followed only exceptionally; (4) the speed with which the infective larvae reach the stomach and intestine following percutaneous infection; and (5) the failure of the larvae to undergo any evident extraintestinal development following percutaneous infection.

With regard to the number of molts involved in the life history of *L. musculi*, this case is paralleled by the development of *Nippostrongylus muris* as determined by Yokogawa (7). The latter species molts only once during its free-living existence, and the larva is infective to rats after discarding its sheath. Yokogawa regarded the infective larva of *N. muris* as a second-stage larva and considered the development of the worm in the lungs as involving 2 stages, though only one molt was present. Following the first parasitic molt in the lungs, Yokogawa regarded the exsheathed larvae as fourth-stage larvae, a view which fits their morphological status. As already indicated, the writers disagree with Yokogawa's interpretation of the

morphological status of the infective larvae and with his assumption that the growth in the lungs which culminates in a molt involves two stages, one molt being suppressed and, instead, regard the infective larva of *N. muris* as well as that of *L. musculi* as morphologically and physiologically identical with other third-stage strongyle larvae. The morphological identity is evident from the structure of the esophagus which is club-shaped and lacks a masticatory apparatus, in contrast to the rhabditiform esophagus containing a masticatory apparatus which is characteristic of second-stage as well as first-stage strongyle larvae. Moreover, the mouth of third-stage strongyle larvae is closed, whereas in the first and second stages the mouth is open. In this respect, too, the two species under consideration agree with third-stage rather than with second-stage larvae. In addition to the facts already cited, the time which elapses between the hatching of the larvae and the attainment of the infective stage, 4 days in the case of *L. musculi* and 4 to 5 days in the case of *N. muris*, lends additional support to the view that one molt has been suppressed. Under favorable conditions, strongyle larvae molt about 2 days after hatching and molt again two or three days later, the entire preparasitic development being completed in about 4 to 5 days.

From the viewpoint of their behavior, the exsheathed free-living larvae of *N. muris* and of *L. musculi* show the characteristic habits of third-stage larvae. The exsheathed larvae of both forms migrate upwards in culture dishes and bottles and are capable of infecting susceptible hosts, behavior features not exhibited by any known second-stage strongyle larvae. In the opinion of the writers, the preparasitic development of *N. muris* and *L. musculi*, which culminates in a molt, corresponds to the preparasitic development of other strongyles, the first molt being suppressed; the single ecdysis which takes place corresponds to the second molt of other strongyles. It is perhaps significant that the only two species of strongyles of which the free-living development involves only one molt, so far as known at present, are rather closely related and belong to the family Heligmosomidae. It is possible that the suppression of the first molt may be found to be a common feature in the life history of the members of this family.

Since the various stages in the development of nematodes after hatching are separated by molts, the infective larvae of *Longistriata* and *Nippostrongylus* are actually second-stage larvae having a morphology characteristic of third-stage strongyle larvae. However, in order to avoid the designation "third-stage larva" for a worm which has molted only once, the writers propose the following terms for the

stages in the development of strongyles after hatching: First preinfective larva; second preinfective larva; infective larva; preadult; adult. In the two species under discussion, the first two stages are not separated by a molt and only four stages appear after hatching, namely, (1) preinfective larva, (2) infective larva, (3) preadult, and (4) adult. The proposed designations, which have been used in this paper, have the additional advantage of eliminating the term "fourth-stage larva" for a stage in development which can no longer be regarded as larval, since sex differentiation is not only well established but is readily apparent even on superficial examination.

It is quite evident, in view of the rather ample data available on the post-mortem findings in mice at various intervals following percutaneous infection, that the larvae of *L. musculi* become arrested in the lungs only exceptionally even if they do migrate through the respiratory tract. This, as well as the probability of a more direct course of migration to the alimentary canal, accounts for the exceptionally rapid appearance of the larvae in the stomach and intestine following skin penetration. As is well known, the migratory course of various species of hookworms following percutaneous infection is from the skin to the lungs and results in a considerable delay of the larvae in these organs. The boring of the larvae through the pulmonary capillaries, their migration into and from the alveoli, along the ramifying bronchioles, up the bronchi and the trachea and thence into the esophagus, is evidently time consuming and accounts for the relatively long interval elapsing between the penetration of the larvae into the skin and their arrival in the intestine.

The essential facts in the development of *L. musculi* following the entry of the larvae through the skin are in striking contrast to those observed by Yokogawa and others with reference to the development of *N. muris*. The infective larvae of the latter species develop in the lungs, molt there, and enter the intestine as preadults. In fact the writers (4) have shown that infective larvae of *N. muris* are incapable of surviving in the digestive tract of rats, and if they fail to reach the lungs after being swallowed, they pass into the large intestine where they die and are expelled with the feces. *L. musculi*, on the other hand, undergoes its entire parasitic development in the small intestine regardless of the portal of entry into the body of its host. The ability of the infective larvae of this species to penetrate the skin is not correlated with an extraintestinal developmental phase as it is in the case of *N. muris*. The infective larvae of the latter, as a matter of fact, are not well adapted to utilizing the mouth as a portal of entry into

rats, as shown by Yokogawa (7), Africa (1) and by the writers (5). *Nippostrongylus* is a striking example among strongyles of an almost obligatory skin penetrator, since this avenue of entrance into its hosts leads to the lungs whereas an entry through the mouth results as a rule in only a slight infestation or in a failure of the worms to become established in the host.

COURSE OF INFECTION WITH L. MUSCULI

The course of infection with *L. musculi*, in so far as this can be determined by quantitative studies in the form of counts, made at more or less regular intervals, of the number of worm eggs in definite amounts of the feces of the experimentally infected white mice, was studied in 5 host animals of which 3 were infected percutaneously and 2 through the oral route. Each mouse received an initial dose of 500 larvae, and the 3 mice which were superinfected received a similar second dose. The feces of these mice were examined on the sixth day following experimental infection, with negative results in all cases. Eggs were found by the salt flotation technic on the 7th day and the counts were begun either on that day or the next day.

Figure 15 is a graphic representation of the rise and fall in the egg output of the worms in mice nos. 23, 24 and 25 which were infected through the skin. The graphs show that the peak of egg production in the case of mice nos. 23 and 24 was reached on the 9th day after experimental infection, or 2 days after eggs were first noted in the feces, and that eggs were no longer demonstrable in the feces on the 14th day in case of mouse no. 24 and on the 16th day in the case of mouse no. 23. The two mice were superinfected through the skin 18 days after the first infection.

Mouse no. 23 was kept under observation until it died, 69 days after superinfection. During this period only one egg was discovered in the feces on the 9th day and three eggs on the 15th day after superinfection; these eggs were demonstrated by the salt flotation technique. At necropsy no worms were found in the intestine of this mouse.

Mouse no. 24 began to discharge eggs 7 days after superinfection and was still discharging eggs 41 days after superinfection; two days later this mouse died and post-mortem examination showed 18 gravid females and 13 males in the small intestine.

Mouse no. 25 reached a peak of egg elimination 8 days after experimental infection and showed no eggs in the feces 5 days later. Two days after the mouse became negative it was superinfected

percutaneously. An inspection of the graph shows that the slight egg output from the worms of this mouse, beginning 9 days after superinfection, disappeared after a few days, and that following this no eggs were demonstrable in the feces for 30 days, except once as noted on the graph. This was followed by the reappearance of small numbers of eggs in the feces during a period of 15 days at the end of which, 65 days after superinfection, the mouse died. Post-mortem

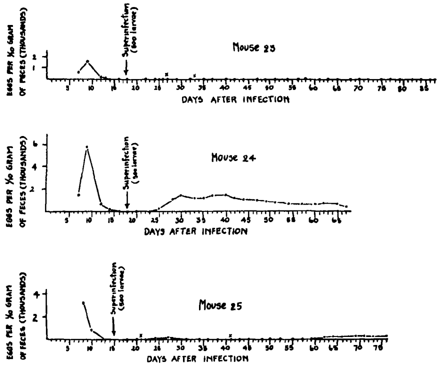

Fig. 15.—Graph of eggs per one-tenth gram of feces of mice nos. 23, 24 and 25, each infected percutaneously with 500 larvae, and superinfected percutaneously with 500 larvae as indicated. x indicates 1 to 3 eggs in total fecal output.

examination showed 22 worms in the intestine, 9 males and 13 gravid females.

From these data it is evident that following percutaneous infection of mice with *L. musculi*, the egg output quickly reached a peak and that this was followed by an equally rapid decline. A superinfection, in so far as available data show, either failed to reestablish egg production, or reestablished egg production at a level lower than that attained during the initial infection. However, the egg output following the second infection, was more stable and persisted for a rela-

tively long time. The egg output of the worms in mouse no. 25, following superinfection, involved a prolonged negative phase between 2 positive phases, due perhaps in part to a delayed development of

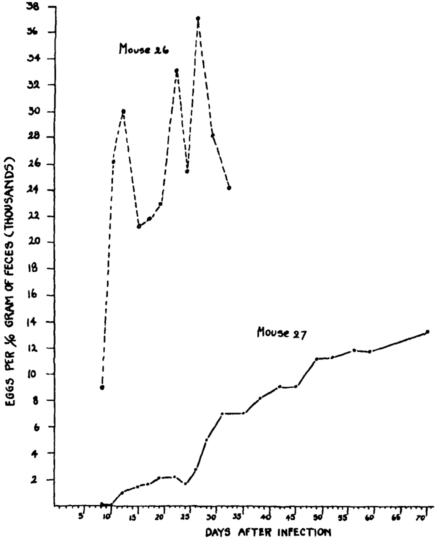

Fig. 16.—Graph of eggs per one-tenth gram of feces of mice nos 26 and 27, each infected through the mouth with 500 larvae.

some of the worms, similar to the delayed development of *Nippostrongylus muris* following superinfection, as determined by Schwartz, Alicata, and Lucker (5), in 1931, and subsequently confirmed by Chandler (2), Spindler (6), and Graham (3).

The graphs shown in fig. 16 are of the egg output of mice nos. 26 and 27 infected through the mouth. An inspection of these graphs shows not only a tremendously large output of the eggs as compared to that of the mice infected percutaneously, but shows also a prolonged persistence in egg production at high levels. Eggs appeared in the feces of mouse no. 26 seven days after experimental infection and were still being discharged in large numbers 25 days later when the last egg count was made. Two days subsequent to the last egg count this mouse died. Post-mortem examination showed 53 worms in the small intestine, 18 males and 35 gravid females.

In mouse no. 27, infected on the same date as mouse no. 26, eggs appeared 7 days following percutaneous infection. The increase in egg output was more gradual than that in mouse no. 26. Egg production was still on the increase 63 days after experimental infection, the date on which the last count was made. Three days later the mouse died; post-mortem examination showed 103 worms in the intestine, 41 males and 62 gravid females.

It is evident from an inspection of the graphs (figs. 15 and 16) and from the data given in the text, that while eggs were first demonstrable in the feces of the mice 7 days after experimental infection, regardless of the portal of entry of the larvae, the number of eggs discharged by the worms and the duration of egg production are correlated with the portal of entry of the larvae. The percutaneous route resulted in a relatively slight egg output which lasted but a few days, whereas the entry of the larvae through the mouth resulted in a relatively tremendous output of eggs which persisted at high levels as long as the mice survived. The rapid disappearance of eggs from the feces of percutaneously infected mice can not be accounted for on the assumption of slighter infections resulting from the entry of the larvae through the skin, as compared to those resulting from the ingestion of larvae. In a series of experiments involving 5 mice (nos. 28 to 32) infected percutaneously with 300 to 500 larvae, post-mortem worm counts made from 7 to 16 days following infection, yielded 102, 158 and 86 worms, respectively, in the mice given 500 larvae each, and 47 and 55 worms, respectively, in the 2 mice given 300 larvae each, with males and females present in fairly equal numbers in all cases. These figures compare favorably with the number of worms recovered from mice nos. 26 and 27 following infection through the mouth. Assuming, therefore, that the wide discrepancy in the number of eggs produced by the worms following the two avenues of entrance into the host are not due to differences in the percentage of

larvae which actually reached the intestine and developed there to maturity, it is probable that the migration of the larvae from the skin to the intestine, involving a passage through various tissues and cavities, stimulated the defense mechanism of the body. The response to this stimulation is apparently of a sort which interferes with egg production even before the worms die and are eliminated from the intestine. The amazingly low egg output from the worms in mice nos. 24 and 25, despite the presence of 18 and 13 female worms, respectively, in these two animals, as compared to the egg output of the worms in mouse no. 26 which had approximately only twice as many females, or even as compared with the egg output of the worms in mouse no. 27 which harbored 62 females, is certainly suggestive of a host resistance involving among other things inhibition of egg production.

In the case of *N. muris*, the inhibition of development and of egg production has been confirmed by several workers, as already stated, since Schwartz, Alicata and Lucker (5) called attention to this fact. Experimental percutaneous infection of rats with *Nippostrongylus*, as determined by these workers, resulted in most cases in the rapid attainment of a peak in egg production followed, as a rule, by an equally rapid decline. In superinfections, produced following this decline, but few or no eggs were demonstrable in the feces of a large proportion of rats, despite the presence in the intestine of relatively large numbers of worms, including gravid females. The course of infection with *Nippostrongylus* in rats following the invasion by larvae through the skin is similar, as a rule, to the course of infection with *Longistriata* in mice following the same portal of entry. This general similarity in egg production coupled with the same avenue of entrance into the body, suggests that the passage of the larvae of the two species under discussion through the tissues of their respective hosts brings about a defense reaction to the invasion of the parasites which terminates the egg production and, therefore, the multiplicative capacity of the worms, in a few days.

SUMMARY

Under favorable conditions, the eggs of *Longistriata musculi* hatched in about 24 hours after they were eliminated from the host, *Mus musculus*, and the larvae attained their full development in 4 days. Following one preparasitic molt, the larvae were infective to mice.

Although the infective larva has molted only once, its morphology

and behavior are similar to known third-stage trichostrongyle larvae. The view is advanced that the first molt has been suppressed, and the molt which takes place corresponds to the second preparasitic molt of related nematodes. As established by visible molts, it is a second-stage larva, but, as established by morphology and behavior, it is the equivalent of the infective third-stage larva of trichostrongyles in general.

The following designations are proposed in this paper for the stages in the development of strongyles: (1) First preinfective larva; (2) second preinfective larva; (3) infective larva; (4) preadult; and (5) adult. The suppression of one molt during the free-living period reduces the life cycle to 4 stages.

White mice were infected with *Longistriata* through the mouth and through the skin, either portal of entry leading the worms to the small intestine, where they undergo their entire development, accompanied by two molts.

A few hours after percutaneous infection, larvae were found in the stomach and intestine and they became localized in the intestine exclusively 24 hours after having been placed on the skin.

The precise route taken by the larvae from the skin to the intestine has not been determined; evidently, the migratory course usually followed by skin-penetrating nematodes, involving a passage through the lungs, was followed only exceptionally by *L. musculi*, so far as available data show.

Preadult worms, showing unmistakable sex differentiation, were found in the intestine of white mice about 48 hours after experimental infection through the mouth or skin, and final stage worms (adults), not fully grown, were found in these host animals 5 days after entry by either portal.

Regardless of the portal of entry of the larvae, eggs were first noted in the feces of experimentally infected mice 7 days after the administration of larvae.

The period of egg production in 3 white mice infected percutaneously with 500 larvae was limited to approximately two weeks. Superinfection with 500 larvae following the apparent cessation of egg production, yielded practically negative results in one case coupled with absence of worms in the intestine, and resulted in only a small output of eggs in the two remaining mice which harbored worms of both sexes, the egg output being far below the expected output, considering the number of females present.

Following infection with 500 larvae through the mouth, the egg

output from 2 mice reached a far higher level than that attained following percutaneous infection. Moreover, the high level of egg production persisted until the mice died, 32 and 63 days, respectively, following the ingestion of larvae.

It is suggested that the glaring differences in egg production by the worms, the differences correlated with the portal of entry of the larvae into white mice, is probably due to a marked stimulation of the defense mechanism of the host coincident with the migration of the larvae through various tissues following percutaneous infections. This stimulation is either lacking or is not marked following ingestion of larvae.

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PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

259TH MEETING

The 259th meeting of the ACADEMY was a joint meeting with the Medical Society of the District of Columbia, held in the Auditorium of the New National Museum on Wednesday, November 21, 1934. About two hundred and fifty persons were present. President TUCKERMAN introduced Dr. WILLIAM A. WHITE, Superintendent of St. Elizabeths Hospital, who delivered an address on *The frontier of the mind*, which has been published in full in this JOURNAL **25**: 1–15, 1935.

260TH MEETING

The 260th meeting of the ACADEMY was held in the Assembly Hall of the Cosmos Club, on Thursday, December 20, 1934. About 60 persons were present. President TUCKERMAN called the meeting to order and announced the nature of a series of programs planned for the future before presenting THOMAS R. HENRY of The Evening Star, who spoke upon, *Introducing science to the public*, and AUSTIN H. CLARK of The Smithsonian Institution, who discussed, *Science and the public*.

261ST MEETING

The 261st meeting of the ACADEMY was held in the Assembly Hall of the Cosmos Club on Thursday, January 17, 1935. About sixty-five persons were present.

Doctor ARTHUR L. DAY, director of the Geophysical Laboratory of the Carnegie Institution, delivered an illustrated address on *Public safety in earthquake regions*.

At the close of the address the President declared a recess, and asked the members to remain for the 37th annual meeting of the ACADEMY.

37TH ANNUAL MEETING

The thirty-seventh annual meeting of the ACADEMY was called to order by President TUCKERMAN at 9:15 P.M., January 17, 1935. Thirty-five members were present. The minutes of the 36th annual meeting were read by the recording secretary and approved by vote of the Academy.

The corresponding secretary reported on the membership and activities of the year 1934 as follows: Twenty-eight persons were elected and qualified as regular members. Twenty-two resignations were accepted; twelve of these were resident and ten non-resident members

The ACADEMY stood in respect as the Secretary read the list of six members lost by death:

J. M. ALDRICH	ARTHUR SCHUSTER
K. F. KELLERMAN	HOMER C. SKEELS
E. W. NELSON	H D GIBBS

On January 1, 1935, the membership consisted of 15 honorary members, 3 patrons, and 536 members, one of whom was a life member. The total membership was 554 members, of whom 398 reside in or near the District of Columbia, 133 in other parts of the continental United States, and 23 in foreign countries. The net loss of membership was 1.

The recording secretary's report summarized five public meetings, two of which were joint meetings, one with the Philosophical Society, the other with the Medical Society.

The treasurer's report detailed the financial operations of the ACADEMY with an itemized list of the assets A summary of the report showed:

Cash balance, January 1, 1934.	$1,365.35
Cash receipts to December 31, 1934..	5,132.17
Total cash to be accounted for.	6,497.52
Total disbursements.	3,970.98
Cash balance, December 31, 1934..	2,526.54
Investments, cost at time of purchase, total..	21,096.37

F. B. SCHEETZ, chairman, read the report of the auditors verifying the operations of the treasurer's office and the assets of the ACADEMY. On motion of C. J. HUMPHREYS, both reports were accepted and ordered filed.

JOHN A. STEVENSON, senior editor, read the report of the Journal which covered the publication of Volume 24, for the year 1934. Volume 24 consisted of 576 pages, including an eight page index. This compares with 588 pages in 1933, 572 in 1932, 552 in 1931; and 520 in 1930. It contained 78 original papers, as contrasted with 77 in 1933, 79 in 1932 and 80 in 1931. Forty-five papers were by members of the Academy, and 33 were communicated, of which latter number it should be noted six were by authors who became members of the ACADEMY following the time of publication of their papers. The original papers were illustrated by 42 line cuts and 27 half tones. Space in the volume was distributed among the different sciences as follows:

	Pages
2 papers on Mathematics	25.3
1 paper on Physical geography.	6.5
5 papers on Physics and geophysics	44.3
9 papers on Chemistry, including pharmacology.	37.6
3 papers on Geology, including hydrology and petrology	43.5
1 paper on Biology	1.1
15 papers on Paleontology and paleobotany...	67.2
14 papers on Botany	109.6
20 papers on Zoology	90.2
5 papers on Ornithology, malacology, entomology	42.9
3 papers on Ethnology and archeology.	12.1

Proceedings of the Academy and affiliated societies occupied 53.4 pages, as follows:

The Academy	4.6
Anthropological Society..	1.3
Botanical Society..	3.9
Geological Society.	18.6
Philosophical Society	15.0

Scientific notes and news, and obituaries occupied the remaining 44.1 pages.

The recording secretary read the report of the tellers showing the election of the following officers for 1935: President, G. W. McCOY; non-resident vice-presidents, W. M. CLARK, E. D. MERRILL; corresponding secretary, PAUL E. HOWE; recording secretary, CHARLES THOM; treasurer, H. G.

AYERS; managers for the term of three years ending January, 1938, R. S. BASSLER, C. A. BROWNE.

The corresponding secretary read the nominations for resident vice-presidents representing the affiliated societies, as follows:

Philosophical Society of Washington, O. H. GISH
Anthropological Society of Washington, MATTHEW W. STIRLING
Biological Society of Washington, CHAS. E. CHAMBLISS
Chemical Society of Washington, J F. COUCH
Entomological Society of Washington, HAROLD MORRISON
National Geographic Society, F. V. COVILLE
Geological Society of Washington, H. G. FERGUSON
Medical Society of the District of Columbia, HENRY C. MACATEE
Columbia Historical Society, ALLEN C. CLARK
Botanical Society of Washington, NATHAN R. SMITH
Archaeological Society of Washington, WALTER HOUGH
Society of American Foresters (Washington Section), S. B. DETWILER
Washington Society of Engineers, PAUL C. WHITNEY
American Institute of Electrical Engineers (Washington Section), HERBERT G. DORSEY
American Society of Mechanical Engineers (Washington Section), HERBERT N. EATON
Helminthological Society of Washington, G STEINER
Society of American Bacteriologists (Washington Section), H. W. SCHOENING
Society of American Military Engineers (Washington Post), C. H. BIRDSEYE
Institute of Radio Engineers (Washington Section), J. H. DELLINGER

On motion, the recording secretary was instructed to cast the vote of the Academy for the nominees, and they were declared elected.

President TUCKERMAN appointed past presidents WETMORE and ADAMS to escort Dr. McCOY to the Chair. President McCOY made a brief address and declared the meeting adjourned.

CHARLES THOM, *Recording Secretary*

ANTHROPOLOGICAL SOCIETY

The Anthropological Society of Washington at its annual meeting held on January 15, 1935, elected the following officers for the ensuing year: *President*, MATTHEW W. STIRLING, *Vice-president*, FRANK H H. ROBERTS, JR.; *Secretary*, FRANK M. SETZLER; *Treasurer*, HENRY B. COLLINS, JR.; *Vice-President of the Washington Academy of Sciences*, MATTHEW W STIRLING; *Members of the Board of Managers*, C W BISHOP, G. S DUNCAN, H. W. KRIEGER, T. D STEWART, W. D. STRONG.

A report of the membership and activities of the Society since the annual meeting held on January 16, 1934 follows:

Membership

Life members	3
Active members	45
Associate members	8
Honorary members	18
Corresponding members	18
Total:	92

Deceased	
Active members	1
New Members	
Active members	1
Associate members	1
Total	2

The Society lost through death one of the oldest and most devoted active members, Mr FELIX NEUMANN, February 7, 1934

Members elected during the year were Dr W M COBB and Mr W J WINTER

The financial statement (Treasurer s report) is as follows

Funds invested in Perpetual Building Ass n	$1170 43	
21 shares Washington Sanitary Improvement Co, par value $10 per share	210 00	
2 shares Washington Sanitary Housing Co par value $100 per share	200 00	
Cash in bank	228 37	
Total	$1808 80	
Bills outstanding		
To American Anthropological Ass n	$50 00	
To Printer	3 75	
Total	53 75	53 75
Net Balance		$1755 05

Papers presented before the regular meetings of the Society were as follows

January 16, 1934, 649th regular meeting, *Indian food plants and their historical significance*, by W T SWINGLE, Bureau of Plant Industry, U S Department of Agriculture

February 20, 1934, 650th regular meeting, *The historical implications of Some Algonquian Studies*, by T Michelson, ethnologist, Bureau of American Ethnology

March 20, 1934, 651st regular meeting, *Future problems in anthropology*, by A HRDLICKA curator of physical anthropology, U S National Museum

April 17, 1934, 652nd regular meeting, *Some laws of the early Iroquois league*, by President J N B Hewitt, ethnologist, Bureau of American Ethnology, who gave his retiring address

October 16, 1934, 653rd regular meeting, *Louisiana relatives of the Ohio mound builders*, by F M SETZLER, assistant curator, Division of Archeology, U S National Museum

November 20, 1934, 654th regular meeting, *Archeological explorations in northeastern Honduras*, by W D STRONG, archeologist, Bureau of American Ethnology

December 18, 1934, 655th regular meeting, *How the northern Indian hunts*, by J M COOPER, Catholic University of America

All regular meetings, except the 651st, were held in Room 43 of the U S National Museum

FRANK M SETZLER, *Secretary*

SCIENTIFIC NOTES AND NEWS

Prepared by Science Service

NOTES

The Great Drought of 1934.—Just how bad the Great Drought of 1934 was, has been made the subject of a special study by meteorologists of the U. S. Weather Bureau. All sections of the country, except along the Atlantic coast, the east Gulf area, and the Pacific Northwest, had below normal rainfall and much of the country had either the lowest of record or the total for the year approximated the previous low, Mr KINCER states Colorado, Indiana, North Dakota, Ohio, and South Dakota had the least annual rainfall of record, while Kansas, Montana, Nebraska, New Mexico, Utah, and Wyoming had only about one inch more than their previous low record. Thus approximately one-fourth of the States had in 1934 either the least precipitation of record or the annual totals approximated the previous low. Only one-third of the States had as much as normal. Almost as important as the rainfall in producing unfavorable weather effects were the high temperatures, especially during the growing season, which made less effective the rain that did occur. It was an abnormally warm year everywhere, except locally in the Northeast A large northwestern area had the warmest year of record with some localities showing an accumulated excess of temperature as great as 2,000 degrees, or an average daily excess of nearly 6 degrees.

U. S. Public Health Service.—A sharp outbreak of cerebrospinal meningitis, fortunately not long-lived, occurred in the F.E R.A. transient camps in Washington and Fort Eustis, Va., early in February Hygienic and quarantine measures recommended by officers of the U S Public Health Service were put into effect and brought the epidemic under control

Experiments by Dr. CHARLES ARMSTRONG of the National Institute of Health have shown that mice can be made resistant to encephalitis of the *St. Louis 1933* type by dropping into their noses, at seven-day intervals, a three per cent solution of sodium alum This experimental work, he states, "suggests lines of study which may possibly lead to the development of procedures of practical value in preventing infections contracted by way of the nasal mucous membranes."

Legislation for the promotion of national economic security, now pending before Congress, provides for $10,000,000 to be expended in public health work, of which $2,000,000 is earmarked for basic research.

Geological Survey—Continuing the series of brief reports being sent to State Geologists, there has been transmitted an article on the copper and iron deposits of Virginia, describing recent work under a Public Works allotment. These deposits have been mined intermittently for at least 150 years. First the rich oxidized iron ores were smelted in crude furnaces. Later, methods of iron production improved until a generation or two ago Virginia was one of the leading producers of iron. Concomitantly with the increased iron output, the rich copper ores at water-level were exploited. Now practically all that remains are the original masses of iron sulphide, carrying inconsequential amounts of gold and copper, but these form a large potential reserve of raw material suitable for the manufacture of sulphuric acid.

National Bureau of Standards.—Dr. L. B. TUCKERMAN of the mechanics

and sound division has been asked to deliver the Edgar Marburg Lecture for 1935 at the annual meeting of the American Society for Testing Materials in Detroit next June.

Dr. W. W. COBLENTZ embarked on January 31 for a month's stay in Porto Rico where he is to advise at their school of tropical medicine on methods and equipment for measuring the solar ultra violet radiation useful in therapeutics. He will also carry on personal research on the measurement of the solar ultra violet radiation at this tropical station.

Children's Bureau U. S. Department of Labor.—The rickets studies carried on by the United States Children's Bureau in collaboration with the Pediatric and Surgical Departments of the Yale School of Medicine, have included a clinical investigation of the relation of rickets to defective formation of teeth and to the occurrence of dental caries, the results of which have been described by MARTHA M. ELIOT, M.D. and SUSAN P. SOUTHER, M.D., of the Children's Bureau, and BERT G. ANDERSON, D.D.S. and SUMTER S. ARNIM, D.D.S., of New Haven. The data assembled in this study indicate that enamel hypoplasia of the permanent teeth, especially the type characterized by a symmetrical distribution of defects in those teeth which are forming during infancy and early childhood, is frequently associated with rickets; that the more severe the rachitic process the more frequently do hypoplastic defects develop; and that, conversely, when severe hypoplasia was found, a definite history of moderate or severe rickets was established in nearly all cases by roentgenologic evidence. Dental caries too was found more often in children with a known history of rickets. Howtory, since caries appeared more often in teeth with hypoplastic defects than in those with none, it is possible that the latter relationship may account for the former. The data showed that children who have had several of the severe infectious diseases of childhood (including pneumonia and bronchitis) tend to have defects in the enamel more often than children who have had fewer of these diseases.

U. S. National Park Service.—There appears to be a definite move on the part of interested organizations and individuals to change the status of the Olympic National Monument to that of a national park, and with this possibility in view the National Park Service is carrying on some careful surveys in the area in order to have a full knowledge of the Olympic elk and its migrations before attempting to define boundary lines.

Smithsonian Institution.—The National Zoological Park will receive substantial additions and improvements to its housing accommodations through an allotment of $680,000 of PWA funds announced January 16 by Secretary of the Interior ICKES. Contemplated changes thus far announced by Director WM. M. MANN include an addition to the bird house, a new elephant house, and a house for the small mammals, with special accommodations for the apes. The elephant house and pens will be turned over to the hippopotamus and the rhinoceros, at present in rather limited quarters. To meet an urgent need of the Zoological Park, a machine shop will also be built.

Evidence that the practice of sacrificing a woman before going on the warpath was a widespread practice among North American tribes has been uncovered by Dr. TRUMAN MICHELSON of the Bureau of American Ethnology. He has found traces of this custom in the literature relating to the

Ojibwas and Hurons. Hitherto it was supposed to have been confined to the Pawnee.

New specimens of piranha, the *Brazilian man-eating fish* of the natural history books, have been added to the National Museum collections by B. A. Krukoff.

Carnegie Institution of Washington.—The moon's mountainous surface will be used as an astronomical *yardstick* by Dr. Edison Pettit and members of the astronomical staff of the Mount Wilson Observatory, in an endeavor to obtain information about the surface of the planet Mercury. The percentage of radiant heat in total reflected radiation from the moon's surface varies with the lunar phases, it has been found. Radiological observations will be made on Mercury as it passes through its phases, and this recently acquired knowledge about the moon will be applied to the data thus obtained.

Important scientific messages from the Watheroo Magnetic Observatory in Western Australia to the Department of Terrestrial Magnetism are transmitted through radio station VK5HG in Southern Australia to amateur stations in the eastern United States whence they are received by the Department.

Dr. G. R. Wait, of the Department of Terrestrial Magnetism, by invitation attended the 41st annual meeting of the American Society of Heating and Ventilating Engineers at Buffalo, New York, January 27–30, 1935, where he presented a paper on *Large-ion and small-ion content of air in occupied rooms* by himself and O. W. Torreson.

Volcanoes in Central America are the objective of a two-man expedition from the Geophysical Laboratory, now in the field. The two volcanologists, Dr. J. W. Greig and Dr. E. G. Zies, expect to spend about three months in Salvador and Guatemala.

Dr. Albert F. Blakeslee, Acting Director of the Department of Genetics of the Carnegie Institution of Washington, located at Cold Spring Harbor, Long Island, was elected on January 28 a corresponding member of the Academy of Sciences of the Institute of France.

Helminthological Society of Washington.—The Proceedings of the Helminthological Society of Washington are now being published as a separate journal. It is devoted to the publication of notes and papers in helminthology and related fields and includes parasites of both plant and animal hosts. Those interested either as contributors or subscribers should communicate with the editor, Jesse R. Christie, Bureau of Plant Industry, U. S. Dept. of Agriculture, Washington, D. C.

Pan-American Union.—The meeting held February 10 by the Washington Chapter of the Pan-American Medical Association at the Legation of Panama was devoted to intestinal surgery. A meeting is being planned for March in Georgetown University in honor of Col. B. K. Ashford, who discovered that the so-called tropical anemia in Puerto Rico was really caused by hookworms, thus laying down the basis for a worldwide campaign against the disease. The officers of the Chapter are Dr. Henri DeBayle, Charge d'Affaires of Nicaragua, president, Surg. Gen. Robert U. Patterson, vice-president, and Dr. A. A. Moll, scientific editor of the Pan-American Sanitary Bureau, secretary.

Society of American Foresters.—The Society of American Foresters held its thirty-fourth annual meeting in Washington, January 28, 29, and 30. The afternoon session of Wednesday, January 30, was devoted to a symposium on forest fire control in the coastal plains section of the South. Participating were: A. B. HASTINGS, E. L. DEMMON, W. G. WAHLENBERG, S. W. GREENE, I. F. ELDREDGE, H. L. STODDARD and CHAUCEY KUEHN. It was developed that scientific observations, mostly under control conditions where comparison with like unburned areas is possible, have shown that within reason fire is a good thing for longleaf pine. This species is fire-resistant in all except its first few months of life, because of its thick bark and its trick of protecting its all-important *leader* bud with a dense bundle of leaves. Fire kills less valued competing pines and hardwood species, and lets the young longleaf trees grow

Fire, it has also been found, helps the longleaf seedlings against one of the most serious of pine diseases, the brown spot of their leaves. In one experimental area, young pines kept wholly protected from fire showed twice as much of this infection as did trees of similar age that stood on ground regularly burned over.

Fire appears also to be beneficial to the soil itself, and to the grass that grows among the trees, and thus to the cattle that eat the grass. Unburned areas, to be sure, did have soil somewhat more porous that that in burned areas; but this advantage was offset by the better chemical condition of the burned-over soil Burned-over soil produced twice as much green weight of vegetation, which was also of better nutritive quality than the plants from unburned areas. And cattle grazed in burned-over woods gained more weight and were sleeker-looking than comparison herds kept in fire-free woods.

The common practice of burning the woods every spring is too much. Much less frequent use of fire is calculated to bring better results, in all probability. Tests of just how often the red demon can be invoked with benefit rather than harm are now in prospect.

NEWS BRIEFS

Wild ducks are scarce in Mexico, no less than in this country. Investigators of the U. S. Biological Survey, who are studying certain duck species that nest in the United States and Canada and winter in Mexico, have learned from Mexican sportsmen, as well as from their own observations, that the serious duck shortage felt for some years in this country has its close reflection in our next-door neighbor on the south.

Four thousand acres of forest still in completely primeval condition, in the northwest part of Pennsylvania, have been acquired by the U. S. Forest Service and will be kept as a primitive area. The forest, known as the Tionesta tract, consists of a mixed stand of hardwoods and hemlocks. The tract is of historic as well as scientific interest, for it is the last uncut, unburned remnant of the wilderness that gave the colony founded by William Penn the name *Penn's Woods*—Pennsylvania.

Obituary

HARRY DRAKE GIBBS, consulting chemist, died December 28, 1934, after a brief illness, at Hyattsville, Maryland. He was born March 10, 1872, at Cincinnati, Ohio, and received his technical education at Rose Polytechnic Institute and Cornell University, obtaining the degree B.S. from the latter institution. Stanford University granted him the Ph.D. degree in 1913. He was assistant professor of chemistry, Oregon Agricultural College, 1901–3; research assistant, Stanford University 1904–5; chief chemist of the San Francisco Board of Health, 1905–7. The years 1907–14 were spent in the Philippine Islands where he held a series of important positions including chief, Food and Drug Inspection Laboratory; chief, Department of Chemistry, University of the Philippines; assistant to the director, Bureau of Science; and finally head of the Food and Drug Board of the Islands. Coming to Washington in 1914 as assistant chief, Eastern Food and Drug Inspection District, he became in 1915 chemist in charge of the Color Laboratory of the Bureau of Chemistry. During the war he served as head of the Division of Chemical Technology and Industrial Relations of the National Research Council. At this time he was also head of the Chemical Section of the Department of Science and Research, Bureau of Aircraft Production. Following the war he was research chemist, E. I. du Pont de Nemours & Co., 1919–22; senior chemist, National Institute of Health, 1922–29; and finally consulting chemist, 1929–34. In addition to the Washington Academy of Sciences, Doctor Gibbs was a member of the Philippine Islands Medical Association, American Chemical Society, Deutsche Chemische Gesellschaft, A.A.A.S., Delta Tau Delta and Sigma Xi. He was the author of numerous publications in his chosen field and the holder of a number of patents on chemical processes.

CHARLES DAVID WHITE, of the U. S. Geological Survey, died at his home, 2812 Adams Mill Road, Washington, D. C., February 7, 1935. He was born at Palmyra, N. Y., July 1, 1862, and received the B.S. degree from Cornell University in 1886, that same year joining the U. S. Geological Survey as assistant paleontologist. From that grade he advanced steadily to chief geologist in 1912, a position he filled until 1922. His latest title was that of principal geologist. Doctor White's early work was concerned with the fossil plants from the Cretaceous sediments occurring on the coastal plain from Virginia to Marthas Vineyard Island, but most of his life's work was concentrated on the paleobotanic, stratigraphic, and genetic problems connected with the origin and occurrence of coal and petroleum. Numerous papers on these subjects bear witness to his industry and productivity. At the time of his death he was engaged in an extensive study of the coal floras of Illinois and Oklahoma. Doctor White was honorary curator of fossil plants at the U. S. National Museum; research associate of the Carnegie Institution; and a member of many scientific societies, including the National Academy, American Philosophical Society, Geological Society of America, the American Association for the Advancement of Science, and the Washington Academy of Sciences. He was honored with the Sc.D. degree from the University of Rochester in 1923 and from Williams College in 1925. One of his recent awards was the Walcott medal in April, 1934, for his investigations of primitive life in early geologic strata.

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GENERAL SCIENCE.—*Some interesting applications of deuterium.*[1] F. G. BRICKWEDDE, National Bureau of Standards.

With practically all the elements having isotopes, many in much higher concentrations than deuterium, deuterium owes its importance first of all to the large percentage difference in mass of the two hydrogen isotopes—a difference of 100 percent. As a result all differences in properties depending on mass are much greater in the case of these isotopes than in case of the isotopes of any other element. In the second place deuterium owes its importance to the electrolytic method of separation by means of which it can be obtained in a pure state conveniently and rapidly.

The electrolytic fractionation of deuterium is itself a very interesting problem. The question as to why a separation does occur has not yet been settled, but from experimental and theoretical investigations of this process, we have a much better understanding than formerly both of the evolution of hydrogen at an electrode and of its overvoltage with respect to various metals. It can be definitely stated that this separation does not result from a difference in electrode potentials of hydrogen and deuterium, the difference here being much too small. Differences in mobilities of the ions or in their rates of diffusion will not account for it. It has been deduced that the evolution of hydrogen at an electrode takes place in two steps. The first consists of the discharge of a positive H^+ ion in solution and the adsorption on the metal electrode of the neutral H atom formed. From the energy changes involved, it has been shown that these two actions take place in one step. The second step is the formation of molecules

[1] Published with the approval of the Director of the National Bureau of Standards of the U S. Department of Commerce. The contents of this paper were presented on February 16, before the 1080th meeting of the Philosophical Society as part of a paper entitled, *The uses of deuterium and the measurement of its vapor pressures* The vapor pressure measurements are contained in *Vapor pressures and derived thermal properties of hydrogen and deuterium* by R. B. SCOTT, F. G BRICKWEDDE, H C. UREY and W. H. WAHL, Jour. Chem. Physics, 2: 454 (1934), and in *The ortho- para-vapor pressure difference in deuterium* by F G. BRICKWEDDE, R B SCOTT, and H S TAYLOR, to be published. Received Feb. 16, 1935

from the adsorbed atoms and the desorption of the molecules from the electrode. Fractionation results from differences in the rates for hydrogen and deuterium of one or both of these two processes.

The use of deuterium enables us to do two very desirable things in chemistry. In the first place we can investigate the effect of mass

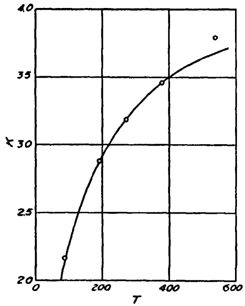

Fig 1.—The equilibrium constant of the reaction, $H_2+D_2 \rightleftharpoons 2HD$, as a function of the temperature in degrees Absolute

independent of chemical nature upon equilibrium concentrations and rates of reaction. In the second place, hydrogen atoms taking part in chemical reactions can be tagged and distinguished from one another.

A reaction that has been extensively investigated is the reversible reaction of hydrogen with deuterium to form hydrogen-deuteride

$$H_2+D_2 \rightleftharpoons 2HD.$$

The equilibrium constant of this reaction, K, a function of temperature, is

$$K(T) = \frac{[HD]^2}{[H_2][D_2]}$$

where [HD], [H_2], and [D_2] denote the concentrations of HD, H_2, and

D_2, respectively. In Fig. 1 are represented[3] the experimentally and theoretically determined equilibrium constants of this reaction. The curve representing the theoretical results was determined by the method for the calculation of thermodynamic quantities from spectroscopic data. Were it just as probable when H_2 and D_2 molecules collide for them to exchange atoms with each other to form HD molecules as it is for HD molecules to exchange atoms on collision to form H_2 and D_2 molecules, the equilibrium constant would be 4. It is seen, however, that the probability of exchange is greater for HD than for H_2 and D_2 and the concentration of HD is less than would be expected from the statistics of collisions. The underlying physical reason for the difference in the probabilities of the exchanges is the difference between the zero point energies of these three molecules, i.e., the difference between their energies at the absolute zero of temperature. When H and D atoms combine with each other, they form H_2, D_2 and HD in concentrations given by this equilibrium constant, $K(T)$. We see then that on collision H and D atoms prefer to unite with their own kind rather than to mix.

Other reactions have been investigated and the theory for the calculation of thermodynamic quantities is substantiated. To know this is important, because the experimental measurement of equilibrium concentrations is very difficult and can not be carried out with the precision or accuracy with which the constants can be determined theoretically.

The rates at which hydrogen and deuterium react with other substances are being studied. In the calculation of the rates at which substances react, factors enter that are not well understood, and satisfactory computations of reaction rates are not possible. Through investigations of the comparative rates of hydrogen and deuterium with other substances, an effort is being made to determine the effect of mass on reaction kinetics. In most cases, the rates with hydrogen are greater than with deuterium. The rates for three interesting reactions are:

$$\frac{\text{rate of } H_2+Br_2\rightarrow 2HBr}{\text{rate of } D_2+Br_2\rightarrow 2DBr} = 5.0 \qquad \text{at } 308^\circ\text{C}.$$

$$\frac{\text{rate of } H_2+Cl_2\rightarrow 2HCl}{\text{rate of } D_2+Cl_2\rightarrow 2DCl} = 13.4 \qquad \text{at } 0^\circ\text{C}.$$

[3] This Figure and Tables I, II, and III were taken from *Hydrogen isotope of atomic weight two* by H. C. UREY and G. K. TEAL, Rev of Modern Physics, 7: 34 (1935).

$$\frac{\text{rate of } H_2+Cl_2\rightarrow 2HCl}{\text{rate of } D_2+Cl_2\rightarrow 2DCl} = 9.8 \quad \text{at } 32°C.$$

$$\frac{\text{rate of } 2H_2+O_2\rightarrow 2H_2O}{\text{rate of } 2D_2+O_2\rightarrow 2D_2O} = 2.5 \quad \text{at } 560°C.$$

To demonstrate the usefulness of deuterium in tagging or distinguishing hydrogen atoms let us consider the simple reaction that takes place when ammonia is dissolved in water:

$$NH_3+H_2O\rightleftharpoons NH_4OH.$$

Ammonium hydroxide is formed and since the reaction is reversible this decomposes into NH_3, dissolved, and H_2O. Now it is of interest to ask whether or not the same three H atoms are attached to the N atom of an ammonia molecule after the decomposition of NH_4OH as were originally attached to it. Or it may be asked if the four H atoms attached to the N of an NH_4OH molecule are equivalent. Let us consider what should happen if we dissolve ammonia in D_2O. If the four H atoms attached to the N of NH_4OH are not equivalent and the same three original H atoms are attached to the N atom after the decomposition of ammonium hydroxide, the following reaction will take place:

$$NH_3+D_2O\rightarrow NH_3DOD\rightarrow NH_3+D_2O.$$

There will be no exchange of the hydrogen of the ammonia with the deuterium of the water. If, however, the four H atoms attached to the N are equivalent then the following reactions will occur:

$$NH_3+D_2O\rightarrow NH_3DOD\rightarrow NH_3+D_2O$$
$$NH_3DOD\rightarrow NH_2D+HDO,$$

and as a result the D and H atoms of the water and ammonia will mix. Experiment shows that they do mix and that when equilibrium is reached, the relative concentrations of hydrogen and deuterium atoms in the water and ammonia are the same. This shows that all three hydrogen atoms of ammonia are in exchange with hydrogen atoms of the water.

In Tables I and II are tabulated a number of exchange reactions.

In the field of physiological chemistry, this ability to tag hydrogen atoms should prove useful. For example we can determine how rapidly a drug taken into the system is absorbed by the blood stream and then eliminated. This can be done by replacing some of the H atoms of the drug with deuterium and then analyzing for the drug by de-

TABLE I.—EXCHANGE REACTIONS BETWEEN WATER AND ORGANIC COMPOUNDS

Compound	Observation
CH_3COONa	No exchange
CH_3COOH	" "
CH_3CHO	1 hydrogen atom exchanges slowly
CH_2O	2 hydrogen atoms exchange slowly
CH_3COCH_3	Very slow exchange in neutral solution Faster exchange in acid solution Very fast exchange in alkaline solution
$CH_3COCH_2COCH_3$	All hydrogens exchange
C_2H_2	Exchange in alkaline solution
Glucose and Cane Sugar	Hydroxyl hydrogens exchange immediately
$(CH_2OH)_2$	One-third of hydrogens exchange immediately
Egg albumen	All hydrogens attached to N atoms exchange
Cellulose	All hydroxyl hydrogens exchange

TABLE II.—INORGANIC EXCHANGE REACTIONS

Reaction	Observation
$H_2(g) \rightleftharpoons H_2O(l)$ and (g)	Exchange in presence of platinum Exchange observed in 6 weeks without addition of catalyst No exchange observed in 19 days without catalyst Exchange in 1–9.5 hours under 340–370 atmospheres pressure Exchange observed without catalyst in Pyrex and quartz vessels at 800° Abs
$H_2(g) \rightleftharpoons HI(g)$	Exchange observed at 400°C and above
$H_2(g) \rightleftharpoons HCl(g)$	Exchange in presence of palladium at 180°C
$H_2O(l) \rightleftharpoons NH_4^+$ (*sol.*)	All hydrogen atoms exchange
$H_2O\ (l) \rightleftharpoons NH_3(l)$	All hydrogen atoms exchange
$H_2(g)+D_2(g) \rightleftharpoons 2HD(g)$	Exchange at high temperatures and on catalytic surfaces. Ni, chromium oxide, Pd, Hg, Pyrex and soft glass, and charcoal at liquid air temperatures do not promote exchange
$KH_2PO_4 \rightleftharpoons H_2O$	No exchange
$[Co(NH_3)_6](NO_3)_3 \rightleftharpoons H_2O$	All hydrogens exchange

termining the D content of the blood. Of course the exchange reactions of the drug must have been previously investigated.

The usefulness of deuterium in biological chemistry can be illustrated by another example. Sodium formate is decomposed by enzyme hydrogenlyase of *Bacterium coli* with the formation of hydrogen and carbon dioxide. The mechanism of decomposition previously accepted for this was:

$$HCOONa + H_2O \rightarrow HCOOH + NaOH$$

$$HCOOH \rightarrow H_2 + CO_2.$$

If this is correct then replacing H_2O with D_2O the following reaction would result:

$$HCOONa + D_2O \rightarrow HCOOD + NaOD$$
$$HCOOD \rightarrow HD + CO_2.$$

No H_2 or D_2, but only HD would be formed.

Experiment shows that H_2, D_2 and HD are evolved in the equilibrium concentrations presented in Fig. 1. Moreover it has been found that in a gaseous mixture of H_2 and D_2 over water the *Bacterium coli* acts like Pt-black as a catalyst in establishing an equilibrium between H_2, D_2 and HD. It must be concluded that the previously supposed mechanism of the decomposition is not correct and that the *Bacterium coli* can react with hydrogen in the atomic form. It therefore seems probable that the decomposition of the formate by *Bacterium coli* occurs through atomic reactions with the formation of H and D atoms.

Because of the extreme sensitiveness of certain biological reactions to changes in environment, it was early realized that isotopic water might produce marked changes in many cases. At first biological effects of high concentrations of D_2O were observed by some chemists. The striking observations of *drunk* mice, the failure of tobacco seeds to sprout, and the death of guppy fish and tadpoles in D_2O, were reported. Fermentation by yeast cells was found to be so much slower that bread made with heavy water would take about one week to rise.

Later, biologists realizing that experiments carried out with low concentrations of deuterium should be more significant biologically in determining the effect of deuterium under approximately normal conditions, subjected various organisms to water containing 0.5 percent and less of D_2O. All experimenters have not found the same effects. It has been reported that *Spirogyra*, or pond scum, lives twice as long in 0.06 percent D_2O, and that some flatworms, *Phagocata gracilis*, placed in ordinary water without food shrank to 1/5 their size in five months, whereas in 0.06 percent heavy water there was only a slight diminution in size. It has also been reported that the growth of *Aspergillus niger;* the germination of conidia of the powdery mildew of wheat, *Erysiphe graminis tritici;* the root growth of wheat and the O_2 consumption by wheat seedlings showed no significant difference between the influence of ordinary water and that of water containing 0.05 and 0.5 percent D_2O. Other experiments, however, indicated that in the case of some bacteria low concentrations of D_2O—of the order of 0.5 percent—have a stimulating effect on the rate of oxygen absorption, whereas in high concentra-

tions—approaching 100 percent—the reverse is true, the rate of oxygen absorption being decreased.

In the field of nuclear physics deuterium has found one of its most important applications. It has added to the material particles used in the investigation of the structure of the nucleus, namely, the proton, neutron and α-particle, another, the deuteron (deuterium nucleus) which can be given great speeds in high voltage tubes and then used to bombard and transmute nuclei of other elements. In some respects the deuteron has proved to be more interesting than the proton. The highest energy material particles ever produced in a laboratory under controlled conditions are the helium nuclei resulting from the bombardment of Li^6 with deuterons. (The superscript designates the atomic weight of the isotope.) The two helium nuclei formed by this nuclear reaction

$$D^2 + Li^6 = 2He^4$$

have ranges in air of 13.2 cm. This is greater than the range of the longest α-particles from any of the radioactive elements. It would require 23,000,000 volts to give them their observed speeds. The transmutations resulting from the bombardment of deuterium with deuterons is unique in that it is the only known case in which a transmutation results from the bombardment of a particle with an identical particle. Two nuclear transformations can take place

$$D^2 + D^2 = T^3 + H^1$$
$$D^2 + D^2 = He^3 + \text{neutron}.$$

The symbol T denotes tritium, the hydrogen isotype of atomic weight 3. The first of these is the most abundant of all known nuclear reactions, i.e., a far greater number of transformations result per million bombarding particles than in the case of any other known reaction. The first reaction is the only one known in which another isotope of the same element is formed, instead of another element. In the strict sense of the word this is not a transmutation.

In the production of artificial radio-activity, deuterium surpasses α-particles and protons in effectiveness. It is reported that high speed deuterons render 14 of the lighter elements (Li, Be, B, N, C, O, F, Na, Mg, Al, Si, P, Cl and Ca) radioactive emitting positive electrons in their disintegration. Of these elements only B and C become radioactive under proton bombardment.

Just as deuterium made possible the investigation of the effect of mass apart from chemical nature upon chemical properties, it makes

possible the investigation of mass upon physical properties. Previously this was not possible. The change in physical properties due to difference in mass in going from one element to another is far overshadowed by the change due to the difference in chemical nature. A *pure* effect of mass on physical properties is illustrated in Table

TABLE III.—PROPERTIES OF H_2O AND D_2O

Property	H_2O	D_2O
Density$_{25}^{25}$	1 0000	1.1079
T of maximum density	4 0°C	11 6°C
Molar volume at temperature of maximum density	18 015 cm^3	18 140 cm^3
Lattice constants of ice a	4 525A	4.505A
b	7 39A	7 36A
Volume of the ice cell	131 0A^3	129 3A^3
Mole volumes of the ices 0°C	19 65 cm^3	19.32 cm^3
Dielectric constant	81 5	80 7
Surface tension	72 75 dynes/cm	67 8 dynes/cm
Viscosity in millipoises 10°C	13 10	16 85
20°C	10 09	12 60
30°C	8 00	9 72
Molar magnetic susceptibility liquid at M.P.	12 93	12 66
solid at M.P.	12 65	12 54
at 20°	12 97	12 75
Refractive index 20°C NaD line	1 33300	1.32828
Molar refraction 20°C NaD line	3.7121	3 665
Verdet constant $\lambda = 5893$A	0 013067	0 012556
Min /gauss cm $\lambda = 5460$ 7A	0 015395	0 014793
M.P.	0 0	3 802
B.P.	100 0	101 42
Heat of fusion	1436 cal	1510 cal
Heat of vaporisation 25°C	10484 cal.	10743 cal
Equivalent conductance at 18°C	H^+ in H_2O 315 2	D^+ in D_2O 213.7
K^+	64 2	54 5
Cl^-	65 2	55 3
Solubilities, molalities		
NaCl 25°C	6 145	6 145×0 92
$BaCl_2$ 20°C	1 72	1.72×0 88

III in which the properties of H_2O and D_2O are compared. The difference between the values of these properties for H_2O and D_2O are larger than was expected and as yet are not quantitatively explained.

The effect of mass is even more striking in the case of molecular hydrogen and deuterium at low temperatures. The boiling and freezing point temperatures, in degrees absolute, of hydrogen and deuterium and their corresponding vapor pressures are given in Table IV. Table V contains the latent heats of transition and the densities of the solids.

At the freezing point of hydrogen, 13.92° Abs., the vapor pressure of solid deuterium is only 5 mm of Hg or 1/11 of that of solid hydrogen. Before the vapor pressure of deuterium was measured it

TABLE IV.—BOILING AND FREEZING POINTS

	T in Degrees Absolute	Vapor Pressure mm of Hg	
		H_2	D_2
Boiling point of deuterium	23 59° Abs.	1753	760.0
Boiling point of hydrogen	20.38	760 0	256.2
Freezing point of deuterium	18 71	447.5	128.7
Freezing point of hydrogen	13 92	54	5 2

TABLE V.—MOLECULAR VOLUMES AND LATENT HEATS OF TRANSITION

	H_2	D_2
Volume of 1 gram molecule weight of solid	26.15 cm³	23 15 cm³
Heat of fusion	28 cal/mol	47 cal/mol
Heat of vaporization of liquid at 20 38° Abs	216 cal/mol	307 cal/mol

was calculated from theory. The theory predicted that at this temperature the vapor pressure of deuterium would be 16 mm or only a little less than 1/3 of that of solid hydrogen. The observed values were introduced in the theoretical equations, and quantities were derived which could be compared with the results of other experiments. Assuming the validity of the vapor pressure theory, it was shown that the coefficient of expansion of solid hydrogen must be abnormally large and that for solid deuterium small. From the derived data, the specific heat at constant volume for solid hydrogen, a quantity which is difficult to measure and previously unknown, was calculated. In Table VI are listed values of the specific heats at constant pressure, C_p, and at constant volume, C_v. For solid hydrogen at 14° Abs. $C_p - C_v$ is 2 times C_v, and at 10° Abs., 2.7 times C_v, whereas for most solids the difference between C_p and C_v is negligibly small in comparison with C_v. This anomaly in solid hydrogen is a consequence of its large coefficient of expansion.

TABLE VI.—SPECIFIC HEATS OF SOLID HYDROGEN AT CONSTANT PRESSURE AND CONSTANT VOLUME

T Degrees Absolute	C_p Observed	C_v Calculated
10° Abs	0 59 cal/mol	0 16 cal/mol
13 92	1 32 cal/mol	0 42 cal/mol

The differences between the physical properties of hydrogen and deuterium and their compounds are in general larger than was expected. In cases where the differences have been accounted for, new or further knowledge concerning hydrogen itself has been acquired.

As an example: It has been learned from a comparison of the vapor pressures of hydrogen and deuterium that solid hydrogen has an unusually large coefficient of expansion, and that for solid hydrogen $C_p - C_v$ is much larger than C_v itself, whereas in the case of most solids, the difference is negligibly small.

This new line of isotopic research in physics will not stop with deuterium but will be extended to the isotopes of other elements. Experiments are already under way to separate the isotopes of Ne, C, N and O in quantities large enough to determine their physical and chemical properties.

The observed differences between the biological, chemical and physical properties of hydrogen and deuterium and their compounds appear all the more striking when we recall the time when it was thought that all properties, reduced to the gram molecular basis, with the exception of those properties which depend upon the velocity of motion of the molecules, as the viscosity of a gas, were the same for all isotopes of the same element. Indeed Soddy, the discoverer of isotopes, does not call deuterium an isotope of hydrogen, because he looks upon the indistinguishability of properties, reduced to the gram molecular basis, as an essential characteristic of isotopes. It must be conceded to Soddy that hydrogen and deuterium behave like different substances but we have today a more fundamental definition of isotopes and a better understanding of the effect of mass on physical and chemical properties. As Lord Rutherford has put it, "much water has flowed under the bridge" since Soddy's discovery of isotopes in 1913.

GEOLOGY.—*Pre-Devonian structural zones in Scotland and eastern North America.*[1] ANNA I. JONAS, U. S. Geological Survey. (Communicated by W. W. RUBEY.)

Scotland, although covering a small area, about 40 miles wide and 250 miles from north to south, is of great interest geologically because it contains parts of several pre-Devonian belts of sedimentation with a complicated tectonic history. The structures which trend both northwestward and northeastward are cut off abruptly at the coast in both directions and their continuations have been sought in adjoining lands, Fennoscandia, Spitzbergen, and Greenland.

This brief discussion is based largely on the work of others and is given as the result of my participation in the second excursion of the

[1] Published by permission of the Director, U S Geological Survey Received January 5, 1935

Pre-Cambrian Association held in Scotland August 18, 1934, under the leadership of Professors Bailey, McCallien, Read and Tilley. "The International Association for the study of the pre-Cambrian and Old Mountain Chains," as it is called, was organized by Sederholm in 1930 and holds its excursions the year following the meetings of the International Geological Congress. The next field meeting will be in Czechoslovakia under the leadership of Radium Kettner of Prague. An account of the present position of the organization of the Pre-Cambrian Association and of the second excursion was published in December, 1934 (1).[2]

Pre-Devonian rocks of Scotland.—Scotland is made up from south to north of the Southern Upland, the Midland Valley, and the Highlands. The last major folding was pre-Devonian, Caledonian, in age, and all younger rocks show relatively unimportant disturbances. The Midland Valley, occupied by down-faulted Devonian and Carboniferous rocks and their intrusives and extrusives, separates the folded belts of the Southern Upland and the Highlands. The Southern Upland contains Ordovician and Silurian rocks. The Highlands are divided into 3 parts; the Southern and Central Highlands contain the Moine and Dalradian Series, both metamorphosed and folded, as were the rocks of the Southern Upland, during Caledonian orogeny. The Southern Highlands are separated from the Midland Valley south of them by a normal fault, the Highland border fault. The Central Highlands is cut in two by the Great Glen which extends along another normal fault, the Glen fault of Jurassic or younger age. The Caledonian canal follows the Glen and connects Loch Linnhe on the southwest with Loch Ness on the northwest.

In the Northwestern Highlands the Moine series has been thrust northwestward over the rocks of another orogenic belt. These rocks include the Lewisian basement of early pre-Cambrian age, composed of an igneous complex intruded into metamorphosed schists and marbles, and is overlain unconformably by late pre-Cambrian Torridonian sandstone. Both series of pre-Cambrian rocks are overlain unconformably by Lower Cambrian quartzites and the Durness limestones whose resemblance to rocks of the same age in the Appalachian Valley will be discussed later.

Moine thrust.—The Moine thrust (2) and its branches forming lower planes of disruption, the Glencoul and Ben More thrusts, produce a belt of imbricate structure 6 to 8 miles broad lying east of an undisturbed tract of Torridon sandstone and Lewisian rocks. The Moine

[2] Numbers refer to the Bibliography given at the end of this paper.

gneiss and the Lewisian igneous complex on the soles of the overthrusts have been ground out into mylonite gneisses and mylonites which were recognized and defined by Lapworth in this area in 1885. These mylonites on the Moine and Glencoul thrusts are well exposed near Knockan and on the shores of Loch Glencoul. The unravelling of the stratigraphy and tectonics of this complicated region is a monument to two great Scottish geologists, Peach and Horne (3).

Undisturbed rocks northwest of Moine thrust.—The Lewisian igneous rocks are well exposed on the shore of Loch Assynt to the Coast at Lochinver and are in large part a light and dark-banded gabbro with pink granite layers. It is a primary gneiss and according to Eskola, a product of the first crystallization of a basic magma followed by differentiation and later intrusion of the types of medium and acid composition. The gneiss is cut by ultrabasic dikes, and contains shear zones which strike northwest across the flow banding of the gneiss which is crushed to a mylonite or augen gneiss in the disturbed zones. The Lewisian gneiss (4) is exposed along the northwest coast of Scotland and in the Isle of Lewis in the Hebrides and all the igneous intrusion and folding in that area was early pre-Cambrian, pre-Torridonian, and the Torridon sandstone was deposited on the deeply eroded surface of this old land area. This sandstone series, which resembles the Triassic of the eastern United States and the Devonian of Scotland, was called Devonian before it was found that Lower Cambrian rocks unconformably overlie it. It also resembles the Jotnian sandstone of Finland and the Sparagmite formation of Norway, the youngest pre-Cambrian rocks of Fennoscandia. The folded structures of the Lewisian gneiss trend west and northwest while all younger rocks of Scotland trend northeastward. Suess (5) and others have suggested that the Lewisian basement belongs to Laurentia and in pre-Cambrian times was connected with the Canadian Shield by way of Greenland, and the whole was part of Eria, an inferred northern continent.

The crystalline schists of Loch Maree into which the granite-gabbro complex of the Lewisian was intruded, have been compared to those of the Grenville. The Lewisian igneous complex where I saw it on the shores of Loch Assynt bears a striking resemblance to the igneous complex of the Reading-Boyertown Hills in eastern Pennsylvania, which lie in the Highland belt of the Appalachian Mountains. The excursion did not visit Loch Maree and therefore I can make no comparison of the sedimentary Lewisian schists with the crystalline schists into which the igneous rocks of the Reading-Boyertown region

are intruded. The Lower Cambrian rocks of northwestern Scotland are lithologically like those in the main Appalachian Valley. The fauna in the two areas also is the *Olenellus* fauna of Arctic type.

Relations of the pre-Devonian Highland rocks southeast of the Moine thrust to those of other areas.—The rocks of the Moine and Dalradian series have only thrust relations with the rocks of Northwestern Scotland, and since they contain no fossils, their age and relations are not definitely known. The Moine series (6), composed of siliceous gneisses and schists, is considered to be pre-Torridonian by Clough, Horne, Gregory, Read, and Eskola, and to be Lewisian by Barrow and Read, and metamorphosed Torridonian by Bailey. It was intruded by the Older granites of the Inchbae and Carn Chuinneag complex (7), perhaps of pre-Cambrian age, before it was folded and metamorphosed. The Moine series at the contact with these intrusives is a hornfels with its current bedding preserved. Later deformation has affected both the intrusives and the Moine in zones striking across their contacts. Read believes that the metamorphism of the Moine series is not Caledonian because the Moine gneisses were metamorphosed before the intrusion of the Ben Loyal alkaline rocks, which are thought to be Ordovician and equivalent to the syenite rocks of the Loch Borolan area where they intrude the Durness limestones of Cambro-Ordovician age. The dislocation metamorphism along the Moine thrust has affected both the syenite and Moine gneisses. The Newer granites, of Silurian age, the Helmsdale granite, Rogart diorite, and the Strath Halladale injection (8) complex also were intruded into the Moine series after the metamorphism. At Cnok na Bieste zenoliths of Moine mica schist are included in the Strath Halladale granite and sillimanite is developed in the adjoining Moine schist. The large granite intrusions near Aberdeen belong also to the Newer granites.

The Dalradian series of quartzites, limestones, slates, and schists overlies the Moine, in part of the Highlands south of the Great Glen fault and extends to the Southern Highland border fault. Bailey believes that it is a pre-Cambrian series, younger than the Moine and overlies it, and that it was metamorphosed and folded and thrust during Caledonian orogeny into four great nappes (9). These structures the members of the excursion studied in the Appin Country south of Loch Linnhe where the Dalradian is not much metamorphosed. The more metamorphosed Dalradian described by Tilley (10) occurs in the Southern Highlands farther south and southwest of Loch Linnhe.

Robert Campbell and other Scottish geologists recognize that the Dalradian series may be Paleozoic and perhaps the metamorphosed equivalent of the folded Ordovician and Silurian rocks of the Southern Upland. This area contains no lower Cambrian rocks but was folded during Caledonian orogeny. In Western Norway where Caledonian folding has been recognized also, a metamorphosed clastic series of Cambrian and Ordovician rocks, first described by Störmer at Ustaoset in 1925, appears in the Bergen arches and has been compared by Kolderup to the Dalradian series. It carries Cambrian fossils of the Fjeld facies of the Baltic type which occurs also in the larger Cambrian belt on the border of Sweden and Norway. In Sweden, east of the border area of Lower Cambrian, is the black carbonaceous shale type of Cambrian of the normal facies of the Baltic type (*Olenus* fauna) which appears in the Midlands of England, in Wales and in Eastern North America in Eastern Newfoundland, Nova Scotia and the Boston area. This type of Lower Cambrian in Sweden and Great Britain lies south and east of the Caledonian orogeny and is not folded. The age of the Upper Cambrian Kolm of the normal series has been determined on the basis of its lead ratio as 425 million years (11).

Southern England was involved in a younger orogenesis than the Caledonian, the Armorican (Hercynian) of Pennsylvanian age, which extends into Western Europe south of the Baltic shield. It contains Mediterranean facies of the Atlantic Province not found in Eastern North America.

Caledonian folding has been recognized not only in Scotland and western Norway and Sweden but its continuation has been found in Spitzbergen and perhaps in northern Greenland. In each country the folded belt is cut off by the sea but similar formations and sequence of diastrophism appear across the water. Holtedahl (12) and other workers have established the Caledonides in Spitzbergen. Koch (13) refers the folding in northern Greenland to the Caledonian in the region between 80° and 83° North Latitude where it extends north of Pearyland across Grantland and Elsemereland on the north side of the pre-Cambrian basement that forms central Greenland. The faunas in northern Greenland are Appalachian, Arctic in type, hence belong to another trough from that of the Caledonian folded belt of Scotland and Norway. Thorolf Vogt and Resser therefore question the extension of the Caledonides to northern Greenland.

Orogenic interpretations of the structure of Scotland.—In Norway and Sweden, according to Vogt and others, the direction of movement

in the Caledonian folding is southeastward towards the Baltic Shield. Franz E. Suess (14) regarded the major direction of the movement as also southeastward. Bailey considers the Dalradian series as in part overlying the Moine, but Suess, on structural and metamorphic grounds, regards their contact as plane of dislocation. He suggests also that the Moine was the creative block which overrode southeastward over the Dalradian series which were back folded on the Moine in the process. He regards the folded non-metamorphic Paleozoic rocks of the Southern Uplands as part of the outer zone of the movement where directed pressure and not load was operative. The Baltic Shield was the foreland for the movement in Scandinavia, but in Great Britain none of the foreland is exposed.

The Moine thrust in northwestern Scotland cuts obliquely across Caledonian structure and Suess (14) believes the Moine thrust is independent of it and younger. He suggests that the Moine thrust has moved northwestward with a greater transport than is apparent and carried the rocks of the main Caledonian trough over the northwestern belt in which there are rocks of another sedimentary trough. In other words, the Caledonides are a one-sided orogen with Fennoscandia as their foreland and the northwestern movement of the Moine thrust is an unrelated and later event.

Early Paleozoic troughs of Scotland and of the eastern United States.—In the early Paleozoic, as has been said, there were two troughs of deposition in Scotland,—the northwestern with an Arctic fauna, the same as that of the main Appalachian belt, and a southern trough with a Baltic facies of the Atlantic Province. It is probable that these troughs were separated in Scotland by a low barrier in the region of the central part of the Highlands.

In eastern North America similar conditions existed in the Cambrian. The main Appalachian belt was open at the north to receive an Arctic sea and fauna like that now found in northwest Scotland and in the Hecklahook formation in Spitzbergen, part of which Holtedahl (12) considers is equivalent to the Durness limestone (13). Koch and Paulsen (15) have reported from Inglefield Land in northwestern and northeastern Greenland such trilobite forms as *Kootenia*, (*Dorypyge*) and *Wanneria*, and the brachiopods, *Paterina*, (*Qutorgina*), etc., characteristic of the Lower Cambrian of the York and Lancaster Valley, Pa. (16). In the Lower Paleozoic the main Appalachian trough continued northeast across eastern New York, western New England, the St. Lawrence Valley, and the Straits of Belle Isle. Schuchert (17)

reports in the Lower Cambrian rocks of Labrador and western Newfoundland such forms as *Micromitra*, *Kutorgina*, and *Nisusia*, a fauna that is typically developed in the Lower Cambrian of the York and Lancaster Valley and also in the Shady limestone (18) of the Southern Appalachians. Resser (18), in his paper on the generalized Cambrian time scale, discussed these faunas and their routes of migration.

The St. Lawrence seaway, until it was blotted out in the Devonian, lay west of the Green Mountain axis and its continuation in Canada, the Sutton and Notre Dame Mountains. In the basin west of the Green Mountain axis the Central Sequence of Keith (19) contains a Lower Cambrian *Olenellus* fauna the same as that of the Appalachian Valley and western Scotland. The Taconic argillaceous sequence of western New England with the Rysedorph Hill fauna of the Atlantic province of Trenton age, according to Prindle and Knopf (20), probably was deposited east of the Green Mountain axis, and owes its present position on the west side of the Green Mountains to overthrust faulting. The Cambrian found in the Boston Basin, southeastern Nova Scotia and Newfoundland contains the normal fauna of the Baltic facies of the Atlantic Province found in the area south of the Caledonian belt in Great Britain and Sweden.

Fragmentation of Eria.—Such faunal similarities in areas now widely separated by deep ocean basins have led paleontologists to the view that in Paleozoic time a land mass, Eria, extended across the northern Atlantic Ocean and afforded a means of migration for shallow-water faunas. It is known that Scotland in Tertiary time was subjected to block faulting and warping which was accompanied by the great lava flows of that period. At that time the Hebrides were cut off from the mainland by rifting. It has been suggested that this period of block faulting completed the breaking up of Eria (21). In the eastern United States similar block faulting began in early Mesozoic time at the beginning of Triassic and when the movement was completed the coastal areas of New England, Nova Scotia and Newfoundland became table lands cut off by the shore lines. The eastern part of Appalachia which may have extended 100 miles east of the present shore line, also is believed to have foundered into the depths of the Atlantic Ocean during Middle Mesozoic time. The geologic similarities on the two sides of the Atlantic have furnished the greatest support also for the Wegener hypothesis of continental drift. The Wegener hypothesis presents difficulties of acceptance perhaps even greater than that of continental fragmentation and does not come under the scope of the present discussion.

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GEOLOGY.—*Comparison of Cambrian rocks of northwest Scotland with equivalent formations of the Appalachians.*[1] G. W. STOSE, U. S. Geological Survey.

During the field excursion of the Pre-Cambrian Association across the Highlands of Scotland in August 1934, the Cambrian section in northwest Scotland was examined at several places, and the writer noted the close resemblance to formations in the Appalachians with which he is very familiar, having described and mapped them in Pennsylvania, Maryland, and Virginia. The Dalradian series, generally regarded as pre-Cambrian, which lie east of the Moine overthrust, were also examined and the writer suggests their possible equivalence to formations in the Appalachians.

GENERAL GEOLOGY

The Paleozoic rocks of northwest Scotland are exposed in a narrow belt that extends from Durness on the north coast to the east side of the Isle of Skye on the west coast, and lie in a zone between the Torridonian mountains which rise above the Lewisian upland on the west and the great Moine overthrust on the east. Members of the Pre-Cambrian Association saw only the lower part of this section, which comprises quartzites and limestones of Cambrian age, exposed in the vicinity of Loch Assynt and Loch Glencoul. Here the basal Cambrian quartzites rest unconformably on nearly horizontal Torridon sandstone, a late pre-Cambrian red grit and conglomerate closely resembling the Triassic red beds of the Appalachians and little more consolidated than those much younger rocks. These little disturbed red beds lie unconformably on Lewisian gneiss, which is exposed on the lower slopes of the mountains. The Cambrian quartzites dip gently east and form the dip slopes of the east ends of high east-west Torridonian ridges between which are deep narrow valleys, many of them occupied by long picturesque bodies of water or lochs. In the lowland east of these mountains are exposed the upper softer calcareous sandstones and overlying limestones of the Cambrian. In the vicinity of Loch Glencoul the Lewisian gneiss is thrust westward over the Cambrian rocks on the flat Glencoul thrust, a split of the great Moine thrust which lies at a higher level in the mountains to the east. The Cambrian rocks dip gently eastward under the overthrust mass, but the formations are repeated several times in shingle-like imbricate plates or schuppen structure, due to the drag of the

[1] Published by permission of the Director, U. S. Geological Survey. Received Jan. 5, 1935.

overthrust mass. The formations examined on the excursion are shown in the chart below. The faunas of the Paleozoic rocks of the Scottish Highlands have been compared with those of the Appalachian section by Grabau, Ulrich, Resser, and others, who recognized their close similarity, but comparison of the lithologic characters of these rocks has not come to my attention.

THE ROCKS

The formations studied on the excursion and those in America with which they are compared are listed in Table 1.

TABLE 1.—COMPARISON OF STRATA IN SCOTTISH HIGHLANDS AND NORTHERN APPALACHIANS

Scottish Highlands		Northern Appalachians	
Durness limestone Sailmhor group Lower part	100′ ±	Middle Cambrian Elbrook limestone	500′
Eilean Dubh group	200′ ±	Lower Cambrian Ledger dolomite	100′
		Kinzers formation (largely shale)	150′
Grudie (Ghrudaidh) group	50′ ±	Vintage dolomite	500′
Serpulite grit Fucoid beds	30′ 50′	Antietam quartzite and Harpers phyllite	1200′
Pipe rock Lower quartzite	500′	Chickies quartzite	1500′
Torridon sandstone Lewisian gneiss		Pre-Cambrian schist	

The quartzites and overlying beds were examined chiefly on the north side of the east end of Loch Assynt. The basal quartzites are cross-bedded and granular and contain coarse grains of glassy quartz and pink feldspar. A few feet of coarser beds or conglomerate are reported at the base, but were not seen by the party. The higher quartzites are massive bedded and contain numerous *Scolithus* tubes and are therefore known as Pipe Rock. Worm tubes of several sizes are described, some large ones are said to be 3 to 4 inches in diameter. The total thickness of the quartzites is about 500 feet. These beds are comparable with the Scolithus-bearing Chickies quartzite in the York-Lancaster region of east-central Pennsylvania, except that in the American section the quartzite is much thicker and therefore

makes higher ridges and the basal beds are generally coarser, in places a cobble bed.

The next overlying formation, Fucoid beds, are described as dolomites, shale, mudstone, and thin beds of dolomite, weathering rusty. What was seen at outcrops is a gray to yellow fine-grained earthy rock with fine black argillaceous streaks, closely resembling the lower part of the Antietam quartzite and the sandy parts of the Harpers phyllite of Pennsylvania and Maryland. Fucoid-like markings on the bedding, whence the name, are now regarded as flattened worm casts. *Salterella* and *Hyolithes* occur throughout this formation and *Olenellus* is reported in the top layers.

The next succeeding formation, Serpulite grit, is an exact duplicate in physical appearance of certain typical quartzite beds of the Antietam of Pennsylvania and Maryland. These characteristic beds include massive white quartzites with slender straight *Scolithus* tubes a yard long; calcareous coarse grit made of round glassy quartz grains, laminated by porous fossiliferous layers, rust-stained on bedding surfaces. These beds contain many *Salterella* hence the name *Serpulite*, and also numerous fragments of *Olenellus*. All these features are duplicated in the Antietam quartzite, one of the key rocks in Lower Cambrian Appalachian stratigraphy and structure. Five species and varieties of *Olenellus* as well as other trilobites, and shells reported from these beds closely resemble, if they are not identical with, forms found in the Lower Cambrian of the Appalachian Valley. The Serpulite grit was seen to grade upward into the overlying dolomite, becoming calcareous at the top and containing rusty fragments of *Olenellus*, just as the Antietam passes into the Vintage or Tomstown dolomite in Pennsylvania.

The next overlying formation, the basal part of the Durness limestone, is called the Grudie (Ghrudaidh) group and is described as a dark, lead-colored mottled dolomite containing numerous *Salterella*. This dolomite seen at a number of places around Inchnadamph and Lake Assynt is a calcareous mud-lump rock and in appearance duplicates the knotty Vintage dolomite of central-eastern Pennsylvania, or the lower part of the Tomstown dolomite of southern Pennsylvania, Maryland, and Virginia. The Grudie is much thinner than the Vintage in America.

The Eilean Dubh group, next in ascending order, is described as a fine-grained white flaggy argillaceous dolomite and limestone. In the area visited we found most of this formation to be a dense massive

light-gray to white pure granular dolomite, weathering creamy, closely similar to the pure massive granular Ledger dolomite extensively quarried in the York-Lancaster Valley of eastern Pennsylvania. The highly fossiliferous Kinzers shale and limestone, which lies between the Vintage and Ledger dolomites in the York-Lancaster Valley, is not represented by similar rock in Scotland. All the rocks above described are of Lower Cambrian age.

Above the pure dolomite beds of the Grudie are thin layers of black oolitic chert, pitted on weathering by dissolved fragments of limestone and possibly of fossils. This is followed by buff siliceous finely wavy laminated calcareous shale or shaly limestone with interbedded thin platy layers of light gray to white fine-grained marble, which is the lower part of the Sailmhor group. This type of limestone was seen by some of the party at only one place, southeast of Inchnadamph, where they pass under a detached remnant of the Glencoul thrust block (klippe) of Torridon sandstone and Cambrian quartzite forming a mountain peak (Beinn nan Cnaimhseag). In lithologic character these beds closely resemble the Elbrook limestone, which also has chert at its base, in southeastern Pennsylvania, and which extends northeastward to the eastern part of the State and southward into Maryland and Virginia. No fossils have been found in these beds in Scotland, but the Elbrook limestone in Pennsylvania contains a scant fauna of Middle Cambrian age.

The upper limestones of the Durness group are not exposed in the area visited because, as previously said, they are cut off by the Glencoul overthrust. As the writer did not see these upper limestones he cannot make a lithologic comparison with the probably equivalent formations in the Appalachians, but fossils reported from them are assigned by Ulrich and others to the "Canadian," or Lower Ordovician, of the Appalachian Valley.

It should be emphasized that the most striking feature about the Cambrian rocks in northwest Scotland, seen by the writer, is their close similarity in lithologic character, sequence, and faunal content with formations of the same age in the Appalachian Valley of eastern Pennsylvania. The only noticeable difference is that their thickness is not so great. It seems reasonable to conclude that all these Cambrian rocks were deposited in a connected basin, probably in the same geosyncline, under very similar climatic and shore conditions, although they are now widely separated by the north Atlantic Ocean.

DALRADIAN SERIES

The Dalradian series, lying east of the Moine thrust in the Southern Highlands, is composed of thick quartzites and boulder beds, limestone, slate, phyllite, and schist that are closely folded and have a very complex structure. Apparently this series was first folded into great recumbent folds or nappes, accompanied by shearing and thrust faulting on their flanks and these flat lying overthrust beds were later closely folded. The Dalradian series is regarded by Professor Bailey, the leader of the excursion, and by some others present on the trip, as pre-Cambrian, which was the reason for their study by the pre-Cambrian Association. We saw the Dalradian series near Ballachulish, on the shores of Loch Leven and of Loch Linnhe, and at Schichallion in the Grampian Mountains. The section as at present established in the Ballachulish and Appin nappes is given below:

BALLACHULISH AND APPINN APPES	SCHICHALLION SECTION
Cuil Bay slates	Loch Tay limestone
Appin limestone	Ben Lui schist
Appin quartzite	Ben Lawers schist
Striped series	Ben Eagach schist
Ballachulish slate	Carn Mairg quartzite
Ballachulish limestone	Killiecrankie schist
Leven schist (phyllite)	Upper Schichallion quartzite
Glencoe quartzite	Tremolite limestone bed
Binnein schist	Lower Schichallion quartzite
Binnein quartzite	Main boulder bed
Eilde schist	Tempar limestone
Eilde flages (Moine)	Banded series
	Gray limestone
	Gray schist
	Tremolite limestone
	Meall Dubh quartzite
	Meall Dubh schist

Professor Bailey in his paper in the Quarterly Journal of the Geological Society of London, 1910, which is accompanied by a geologic map and sections, states that it is not known which is the top or bottom of the section, but he listed the formations in the reverse order from that in the preceding table, Eilde flags at top and Cuil Bay slates at the bottom. In his 1922 paper published in the same journal he stated that he believed the order and sequence published in the earlier report (1910) was correct because it harmonized with his interpretation of the slides as thrusts and with his conclusion that the nappes moved southeastward. In 1924 Vogt presented convincing evidence in the form of current bedding, ripple marks, etc.,

in the quartzites that the section as published by Prof. Bailey was upside down, and in 1930 Professor Bailey in a paper in the same journal accepted this inversion of the section to the order given in the chart above. It is surprising if such a complete change in order of sequence does not make necessary extensive modification of the interpretation of the structure as shown in the published sections and of the conclusions as to the direction of movement. On the excursion, Professor Bailey did not express an opinion as to the direction of movement of the nappes and where the roots of the detached nappes lay. The section in another nappe at Schichallion, now being studied in detail by Professor McCallien of Glasgow University, is given in a parallel column for comparison, but it is not yet correlated with the Ballachulish section.

Only those who have tramped the moors of the Highlands under the adverse conditions of mist and rain can appreciate the labor of the men who have toiled to unravel this complicated geology and the accurate detailed geologic maps they have produced.

A thick series of quartzites and schists at or near the base, 1000 or more feet thick at Schichallion, some quartzites containing pink feldspar grains and some beds at Schichallion containing scattered granite boulders suggesting tillite, impressed the writer in the field as having a Cambrian aspect and the finding of a possible *Scolithus* tube at one place strengthened this impression. The Leven schist, well up in the section near Ballachulish is only a phyllite, much less metamorphosed than the older Bennein and Eilde schists, which is added evidence of the inversion of the column. The black Ballachulish slate, quarried at Ballachulish for roofing purposes, is not so much metamorphosed as the Arvonia slate of Virginia, of Ordovician age. A slaty blue limestone and interbedded carbonaceous slate, called the Ballachulish limestone, impressed the writer as closely resembling the Conestoga limestone of eastern Pennsylvania, also of Ordovician age. Although no fossils have been found in these rocks, the writer ventures to suggest that the Dalradian rocks may be lower Paleozoic formations deposited in a trough southeast of the barrier represented by the overthrust Moine series, and that they may correspond to the Cambrian and Ordovician formations in the Piedmont of the Appalachians, east of the Blue Ridge-Catoctin Mountain barrier.

In the Islands of Islay and Jura, on the southwest coast of Scotland, the belt of Dalradian rocks includes thick quartzites with boulder beds, limestones, slates, and phyllites, similar to the Dalradian at Ballachulish and Schichallion, but the quartzites contain *Scolithus*

tubes, and are called Pipe rock, and other beds, containing worm castings, are called Fucoid beds. They are thus closely similar to the Cambrian rocks of northwest Scotland. Miss Elles, in a paper read at the 1934 meeting of the British Association in Aberdeen, made the statement that she believes these Dalradian rocks on Islay and Jura are Cambrian, and that similar rocks at Schichallion are probably also Cambrian. Peach and Horne, in their posthumous volume on Scotland, 1930, also assign these rocks on Islay and Jura to the Cambrian. At the British Association meeting Doctor Robert Campell also stated that he is of the opinion that beds of the Dalradian series which he has studied northeast of the area seen on the excursion are Paleozoic and he believes that fossils will some day be found to prove it.

GEOLOGY.—*A recent backshore and shoreface terrace along the Severn River, Maryland.*[1] VERNON E. SCHEID, University of Idaho. (Communicated by W. W. RUBEY.)

The ability of unusually large waves to cut a bench and build a terrace in a short time at a higher level than normal was brought to the writer's attention during June, 1934 while at the north shore of Round Bay, Severn River, Maryland. The bay, which is an enlargement of the Severn River seven and one-half miles from its mouth, measures two and one-half miles from northwest to southeast and one and one-half miles from northeast to southwest. The ordinary width of the river is one-half to three-fourths of a mile. Mouthward the river flows southeastwardly in an almost straight line to enter the Chesapeake Bay at Annapolis. The alinement of Round Bay and the lower portion of the Severn River creates a length of fetch of five miles across which the waves may gain in height and energy. The north coast of the bay is at the end of the five-mile fetch and extends in a general east-west direction from Riggs Point to Cedar Point, a distance of slightly less than one mile. Thus when the wind is from the southeast this coast is subjected to the full force of the wave attack.

This section of Maryland is part of Atlantic Coastal Plain and is here underlain by unconsolidated Upper Cretaceous sands and clays with an occasional lens of iron-cemented conglomerate. The shore of the bay is typical of the embayed coastal plain of the Chesapeake Bay region and is the result of shore processes upon a partially submerged youthful topography. The coast line is slightly crescentic and

[1] Received January 16, 1935.

there are hills at and occasionally between the points of the crescents. These same hills have been cliffed by wave action so that the cliff-line[2] presents an undulatory aspect when viewed from the water.

The center of the violent storm of August 21–23, 1933, which damaged the whole eastern seaboard, passed northward over the Chesapeake Bay region. It culminated on the 23rd with southeast gales and exceptionally heavy rain. In twenty-four hours, 7.62 inches of water fell at Baltimore and 5.00 inches at Annapolis.[3] The wind was from the northeast on the 21st and 22nd, but early in the morning of the 23rd it shifted to the southeast and attained a maximum velocity of 50 miles per hour.[3]

The unusually strong winds from the southeast backed up the tidal waters into the many small rivers and inlets of the bay. This action combined with the excessive rains produced very high tides and caused extensive river and lowland floods. For example, in the Baltimore harbor, 16 miles north-northwest of Round Bay, the high tide, which was 7.3 feet[4] above mean high tide, flooded the whole harbor section. Damage from the storm was very heavy. The State Conservation Commissioner, Mr. Swepson Earle, has estimated that about two square miles of coast land was lost in Maryland by wave action. The shift of the wind to the southeast had the same effect at Round Bay as at Baltimore. The southeast-northwest direction of the five-mile fetch allowed the storm waves to reach unusual proportions. Two young men who were at the north shore of Round Bay during the storm informed the writer that there was no exceptional wave activity while the wind was from the northeast, but when the wind veered to the southeast the water level rose approximately six feet and pounded the coast so hard as to destroy a pile-driven pier, several small sheds, and to wrench a one-half horsepower electric water pump from its fastenings and throw it fifteen feet inland and six feet higher. They report that it was during this one day (23rd) that the high-level bench and terrace described below were cut and built.

The profile of the existing backshore (BCDE) and shoreface (EFK) terraces fashioned by normal yearly wave action from the high-level bench (BC) and terrace (CDNPE) produced by the storm of August

[2] Cliff-line. The line of the top of a cliff or series of cliffs, i.e., the line resulting from the intersection of the face of a cliff, or series of cliffs, with the land surface above. Other technical terms follow the usage in Johnson, D. W., *Shore processes and shoreline development*, 1919.

[3] U. S. Dept. Agr. Weather Bur. Climatological Data—Maryland and Delaware Section 38: 29–32. 1933.

[4] Oral communication; Mr. Frank Kipp, Harbor Engineer, Baltimore, Md.

23 is shown in Figure 1. The profile has been made through one of the cliffed hills and shows the present cliff (AB) the top of which is 25 feet above the normal high tide level (EH). It also indicates the changes in the profile of the shore resulting from the wave activity of the storm of August, 1933, and the subsequent normal storms of the winter of 1933–34. BCDE represents the present backshore terrace which varies from zero to six feet wide. It is generally composed

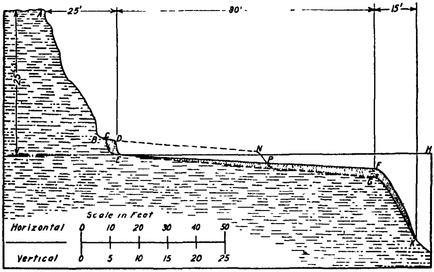

Fig. 1 —Profile of the north shore, Round Bay, Severn River, Md., June 1934.

of two parts, BC, the high-level wave-cut bench now partially covered by cliff debris, and CDE, which is the wave-built portion deposited during the storm. At places either part may form the complete backshore terrace. CE lies beneath CDE and is the basal portion of the pre-storm cliff. The top of the erosion scarp (DE) of the backshore terrace (BCDE) measures two and one-half feet above the present beach created by normal wave activities of the winter of 1933–34. The short-lived high-level terrace that was probably deposited during the storm is indicated as CDNPE. The pre-storm shoreface terrace is shown as EGK while the present shoreface terrace is shown as EFK. The material deposited by wave activity subsequent to the storm is bounded by EFKG and was probably obtained from DNPE, a part of the high-level terrace (CDNPE).

The backshore terrace (BCDE) extends the full distance from Cedar Point to Riggs Point and when seen from a few hundred feet

from shore it has the even appearance of a board walk. The terrace is evidently the result of both cutting and building by the storm waves. The unusually high waves attacked the pre-storm cliffs at the cliffed hills and cut the high-level bench (BC). The material resulting from the cutting of the new bench was immediately deposited on the pre-storm beach or carried along shore by the littoral currents and deposited on the lowland shores. With the subsidence of the storm waters a high-level bench (BC) and terrace (CDNPE) remained on the coast side of the shore. The normal yearly high tides and storm waves of the winter of 1933–34 have cut away much of the high-level terrace (CDNPE) so as to leave the present backshore terrace (BCDE). At some places where the sea cliff is unusually steep and bold no trace of the backshore terrace (BCDE) is seen. This absence may mean that the normal waves of the winter of 1933–34 were able to cut away from the exposed places not only the high-level terrace (CDNPE), but also the bench (BC) that may have been formed during the big storm.

Another effect of the storm observed by the writer was the unusual shallowness of the present shoreface. Formerly, at a distance of 90 feet from the normal high tide shore line (E), the water was four feet deep (G). At present the shoreface at the same spot is only two and one-half feet (F) below normal high tide level (EH). The depth of water at a point 105 feet from the high tide shoreline (E) was formerly and is now 15 feet (K). The new shoreface terrace (EFK) has no doubt been built by normal yearly wave activity. The high-level bench (BC) and terrace (CDNPE) left by the storm of August 23rd was cut into by the waves of the 1933–34 winter and furnished such an excessive load of debris that the waves were not able to remove it completely. This aggraded the former shoreface to form the present shoreface which at point F is two and one-half feet higher than before the storm of August 23rd, 1933.

The above described terrace is certainly not the result of an ordinary large storm unaccompanied by change in the water level. Such a storm would have attacked the pre-storm beach and would have deepened the water. But the severe storm of August, 1933, acted at a high level and probably had very little effect on the pre-storm shoreface and foreshore beach. Instead the waves immediately attacked the pre-storm cliff at a higher level than would ordinarily have been the case. The waves were supplied with an abundance of debris from the cliff so that they built out a small but high-level terrace (CDNPE) upon the surface of the pre-storm beach. The upper surface (CDN)

of the newly built terrace was quickly established as the temporary profile of equilibrium for the storm. With the recession of the storm waters the normal waves began their attack upon the newly established high-level terrace and carried much of the material seaward to aggrade the shoreface as shown in the profile.

GEOLOGY.—*Occurrence of Triassic sediments on the rim of Grand Canyon.*[1] EDWIN D. MCKEE, Park Naturalist, Grand Canyon National Park. (Communicated by JOHN B. REESIDE, JR.)

In 1858, Dr. J. S. Newberry, geologist on Lieutenant Ives' exploring expedition, recognized in the valley of the Little Colorado River where he crossed it about 40 miles below the present town of Winslow a series of rocks which was definitely above and of later age than the highest which he had seen exposed in the walls of Grand Canyon. These rocks, 500 feet thick, were for the most part red sandstones and shales and he referred to them as the "Saliferous series" or "red sandstone series."

During the past sixty years many geologists working in the Grand Canyon region have noted the presence of Newberry's "Saliferous series" in various localities and have contributed to our knowledge of the history and extent of these rocks. Among a large accumulation of data, two things appear to have especial significance. First, since the remnants of these strata are found north, south, east, and west of Grand Canyon and since they are considered on the basis of fossils to have been formed during the Lower Triassic period, it is clearly evident that rocks of this age once covered the entire Grand Canyon area. Second, these remnants furnish evidence that a long period of erosion and wearing away of the region occurred just prior to the beginning of actual Grand Canyon cutting.

South of Grand Canyon isolated remnants of the "Saliferous series" of Newberry, now known as the Moenkopi formation, are found in about nine scattered localities, the farthest southwest of which is in Sycamore Canyon. Both there and in Anderson mesa farther east the exposures are quite extensive laterally and in both cases are protected by lava caps. Since these and the other Moenkopi remnants have considerable bearing on the history of the region, their extent and nature is here summarized:

[1] Published by permission of the Director, National Park Service. Received January 16, 1935.

TABLE 1.—PRINCIPAL OUTCROPS OF TRIASSIC ROCKS SOUTH OF GRAND CANYON

Locality	Thickness	Overlying Beds	Recorder
Sycamore Canyon	300–400′ Moenkopi Cap of Shinarump	Basalt	Robinson (1)
Anderson Mesa N Side	400′ Moenk. & Shin	Basalt	Robinson (1)
Anderson Mesa S Side	550′ Moenk. & Shin.	Basalt	Robinson (1)
Flagstaff	25′–150′ Moenkopi	Basalt	Robinson (1)
San Francisco Peak	? 700′ Moenkopi Shin & Chinle	Basalt	Gilbert (2)
Cedar Ranch N.E of Kendrick	280′ Koenkopi 365′ Shin & Chinle	Basalt	Robinson (1)
Plateau between Diamond and Cataract Creeks	Outlier Moenkopi	None	Newberry (3)
Red Butte 14 mi S.S E. Grand Canyon	600′ Moenkopi 210′ Shinarump	Basalt	Ward (4)
Grand Canyon Rowe's Well	50′ Moenkopi	None	McKee
Grand Canyon west of Moran Point	32′ Moenkopi	None	McKee

Near Grand Canyon, outliers of rocks of Triassic age such as Red Butte to the south and Cedar Mesa to the east have long been recognized for what they are. Remnants of such rocks occurring actually on the rim of Grand Canyon, however, have not heretofore been recorded but since the writer has recently discovered their presence there he takes this opportunity of making known the details. Just west of the Hance trail and east of the steep hill formed by the Grandview monocline is one such exposure extending along the rim for approximately half a mile (Fig. 1). It includes the basal conglomerate member, 8 to 20 feet thick, and a maximum of 12 feet of red to yellow, thin-bedded, argillaceous sandstones above. These red sandstones are also to be seen along the Bright Angel fault not far back from the canyon rim on the road to Havasu Canyon (about two miles S.W. of Rowe's Well) but there the underlying conglomerate and the Kaibab formation are not exposed.

One important feature of the discovery of the Moenkopi formation on the rim of Grand Canyon is that it clearly shows that only a very small part of the Kaibab formation has been removed over much of this area by recent erosion. Beneath the Moenkopi is found only a thin exposure of the so-called A-member or Harrisburg gypsiferous

member of the Kaibab. It consists in this locality of two ledges of limestone, each containing abundant casts of Permian pelecypods and gastropods, separated from each other by a red sandstone. This sandstone is seen at Yaki Point and on the Buggeln hill along the Desert View road where it has been mistaken for Moenkopi sandstone because of its color. It is massive, crumbly, and irregularly-bedded, however, so there is no need for confusion if one compares

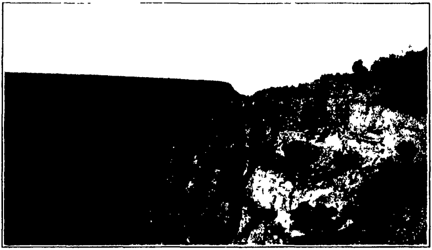

Fig. 1—Moenkopi basal conglomerate and red sandstone resting on Kaibab formation, rim of Grand Canyon, west of Hance Trail

lithologic characters. The underlying limestone is the rock that covers a major portion of the plateau surface.

Along the rim of Grand Canyon west of Hance trail the contact between the Moenkopi and Kaibab formations, representing a break between two great eras of geological hitsory, is plainly visible. The subangular pebbles at the base of the former, ranging in diameter up to 2½ inches but averaging about ½ inch, completely cover the flat limestone surface of the latter and in places fill small depressions and channels cut into it. These pebbles are all of the most durable types of rock—jasper, chert, quartz, etc.—varying greatly in color but probably derived mostly from the Kaibab formation and transported only a short distance. A similar bed of conglomerate has been noted at the base of the Moenkopi where the writer has examined it north of Cedar Mesa, along the Little Colorado Canyon, near Cedar Ridge Trading Post, in Sycamore Canyon and in the valley of the Little

Colorado. Robinson (1) records a similar bed, 5 feet thick, at Anderson Mesa to the south while to the north and northwest it has been noted in numerous localities by other geologists so it probably represents a fairly constant unit at the base of the Moenkopi formation.

The discovery of rocks of the Moenkopi formation on the rim of Grand Canyon adds one more geological period to the remarkably great number already known to be represented in this classical cross-section of the history of the earth. Even more than ever before can the Grand Canyon of Arizona be looked upon as a most impressive open book, recording the story of the ages.

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BOTANY.—*Studies in the Gramineae of Brazil.*—I.[1] AGNES CHASE, Bureau of Plant Industry.

The grass flora of Brazil is of especial importance to American agrostology. Except for Muhlenberg's *Descriptio Graminum,* published in Philadelphia in 1817, the earliest work on American grasses (which in those days included sedges) was *Agrostografia Brasiliensis* by Giuseppe Raddi, published in 1823. More intensive botanical exploration was carried on in Brazil in the first three decades of the last century than in any other part of America.[2] Many species first described from Brazil are found in the North American tropics, for which reason it is necessary for one studying the grasses of the latter region to have a fairly detailed knowledge of the family as found in Brazil.

Since the early Brazilian collections were but poorly represented in American herbaria, three trips have been made to Brazil for the study and collection of grasses, two by the writer, in 1924–25[3] and in 1929–

[1] Received February 7, 1935
[2] See CHASE, *Identification of Raddi's grasses*—This JOURNAL 13: 167–169. 1923
[3] See CHASE, *Eastern Brazil through an agrostologist's spectacles.* Smithsonian Report 1926: 383–403. 1927.

Fig. 1.—*Lithachne horizontalis* from type Plant $\times \frac{1}{2}$; staminate spikelet, pistillate spikelet with immature fruit, and two views of mature fruit, $\times 10$ dia.

30, and one by Jason R. Swallen in 1933–34. As a result of this work and of helpful cooperation from the Jardim Botanico, and the Museu Nacional, Rio de Janeiro, from the Instituto Biologico, Sao Paulo, and of Professor Bento Pickel, Tapera, Estado de Pernambuco, in addition to numerous collections of Gardner, Glaziou, Salzmann, and many others, the Grass Herbarium in Washington now has the largest collection of Brazilian grasses in the world.

The study of this material has brought to light many species previously known from but a single, often fragmentary, specimen, and also a number of undescribed species. The volume on Gramineae for the *Flora Brasilica*, projected by Dr. Frederico C. Hoehne, chief of the section Botanica e Agronomia of the Instituto Biologico, Sao Paulo, is to be prepared by the writer. It is proposed to publish in this JOURNAL from time to time the new species and notes on some of the little known ones.

Duplicate type material of new species will be deposited in the herbarium of the Jardim Botanico do Rio de Janeiro, and so far as material allows in the herbaria of the Instituto Biologico and of the Museu Nacional. Specimens of species from the state of Minas Geraes will also be deposited in the Escola Superior de Agricultura y Veterinaria, Viçosa, and those from Northern Brazil in the Museu Goeldi, Pará.

Lithachne horizontalis Chase, sp. nov.

Perennis, glabra, caespitosa; culmi steriles 10–30 cm. alti; culmi florentes longe repentes, 30–100 cm. longi, internodiis elongatis; vaginae breves; ligula minuta, fimbriata; laminae planae, oblongo-lanceolatae, 2.5–6.5 cm. longae, 8–13 mm. latae, basi inaequaliter in petiolum brevissimum subito contracta; panicula mascula terminalis, 3–4 cm. longa, 2 cm. lata, spiculis 4–6 mm. longis purpureis; spiculae feminae in nodis culmorum repentium solitariae; gluma secunda et lemma sterile 5–6 mm. longa; lemma fertile 3 mm. longum, 2 mm. latum, 3 mm. crassum, album, maturitate fusco-variegatum, cucullatum, gibbum, apiculatum; palea angusta.

Glabrous perennial in tufts of several erect sterile culms, 10 to 30 cm. tall and 1 to 4 vinelike flowering culms, these 30 to 100 cm. long, running on the ground and rooting at the nodes, simple or sparingly branching, the internodes elongate; sheaths short, slightly auricled; ligule minute, fimbriate; blades horizontally spreading, flat, 2.5 to 6.5 cm. long, 8 to 13 mm. wide, abruptly narrowed at the asymmetric base into a minute petiole hispidulous on the upper surface, the blades scabrous on the margin, especially toward the acute to acuminate apex; staminate panicles 3 to 4 cm. long, about 2 cm. wide, terminal on mostly relatively short culms, the spikelets short pediceled on the subcapillary branches, 4 to 6 mm. long, the lemma and palea purple, acute, the 3 stamens with anthers almost as long as the spikelets, the filaments very short; pistillate spikelets solitary on slender peduncles, borne at the nodes of the long creeping culms, protruding from the side of the sheath or from its summit, rarely one or two borne on the

culms producing the terminal staminate panicles, the glume and sterile lemma equal, 5 to 6 mm. long, acuminate, the glume 5-nerved, the lemma 3-nerved, both with a few obscure cross veins; fruit 3 mm. long. about 2 mm. wide and 3 mm. thick, smooth, dull white, becoming strikingly mottled with grayish brown, the lemma 5-nerved, cucullate, strongly gibbous, abruptly apiculate; palea narrow; rachilla joint remaining attached at base, as a white porcelain-like callus.

Type in the U. S. National Herbarium no. 1,255,920, collected on a moist gentle slope above streamlet, near Bello Horizonte, Minas Geraes, Brazil, March 25, 1925, by Agnes Chase (no. 9057). Known only from the type collection

Field notes state that the plants were firmly rooted, forming a colony under coarse herbs and *Paspalum paniculatum* L., the long pistillate culms tangled under vegetation, very slender but not readily breaking in untangling; staminate panicles relatively few, the spikelets falling readily; blades flat but curling almost instantly when plants were dug. The colony was found about half a kilometer beyond the end of the Calafate bonde [street car line]. The specific name refers to Bello Horizonte, the beautiful capital of Minas Geraes, and also to the widely creeping pistillate culms.

This third species of *Lithachne* is strikingly different from the two previously known species, *L. pauciflora* (Swartz) Beauv., rather widely distributed in the American tropics, and *L. pineti* (Wright) Chase, known only from Cuba. *Lithachne pineti*, to which it is the more nearly related, is a much smaller, more delicate species, with smaller blades and spikelets, the fruits smaller, the palea pubescent with thick hairs toward the base.

OLYRA SAMPAIANA Hitchc. Journ. Washington Acad. Sci. 17:215, *f. 1*.—1927.

The type specimen, collected at Reeve, Estado do Espirito Santo, by José Vidal, is almost without underground parts. Specimens collected in 1929 at Alegre, Espirito Santo, about 20 kilometers west of Reeve (*Chase* 10049), show that the roots bear fleshy potato-like bodies, 1 to 2 cm. long and 5 to 8 mm. thick.

BOTANY.—Centrochloa, *a new genus of grasses from Brazil.*[1] JASON R. SWALLEN, Bureau of Plant Industry.

Material of a new genus of the tribe Paniceae was collected by the author in the state of Maranhão, Brazil, during a collecting trip in the early part of 1934. It occurs rather commonly on sterile sandy soil in the states of Maranhão and Goyaz in the valley of the Tocantins river, in the region of Carolina. The name of the genus is taken from the Greek κεντρον spur, and χλοα, grass, referring to the pointed callus which extends well below the articulation between the pedicel and the spikelet.

[1] Received for publication February 7, 1935.

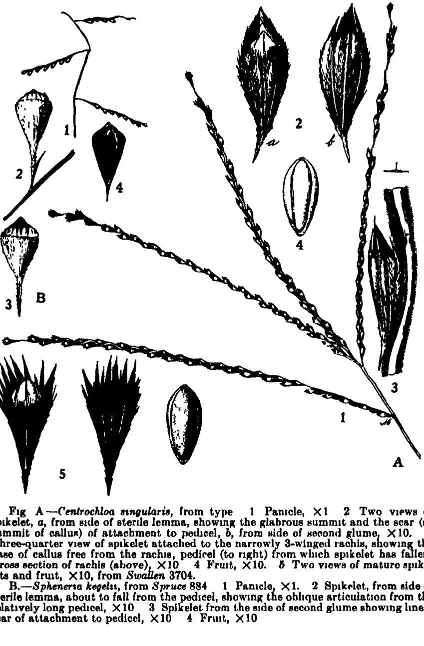

Fig A.—*Centrochloa singularis*, from type 1 Panicle, ×1 2 Two views of spikelet, *a*, from side of sterile lemma, showing the glabrous summit and the scar (at summit of callus) of attachment to pedicel, *b*, from side of second glume, ×10. 3 Three-quarter view of spikelet attached to the narrowly 3-winged rachis, showing the base of callus free from the rachis, pedicel (to right) from which spikelet has fallen, Cross section of rachis (above), ×10 4 Fruit, ×10. 5 Two views of mature spikelets and fruit, ×10, from *Swallen* 3704.

B.—*Spheneria kegelii*, from *Spruce* 884 1 Panicle, ×1. 2 Spikelet, from side of sterile lemma, about to fall from the pedicel, showing the oblique articulation from the relatively long pedicel, ×10 3 Spikelet from the side of second glume showing linear scar of attachment to pedicel, ×10 4 Fruit, ×10

Centrochloa Swallen, gen. nov.

Spiculae solitariae, biseriales, breviter pedicellatae pedicellis infra spiculam articulatis, lemmate fertile a rachi averso; callus infra articulum elongatus, arcuatus, acuminatus; gluma prima nulla; gluma secunda subhyalina, cucullata, inter nervos dense hispida; lemma sterile glumae secundae simile, pilis brevioribus; lemma fertile oblongum, marginibus planis.

Gramen annuum, laminis conduplicatis, racemis 2–7 subdigitatis divergentibus.

Spikelets solitary, with the back of the fertile lemma turned away from the rachis, short-pedicellate, readily disarticulating from the pedicel, in two rows on one side of a narrowly winged rachis, the rows separated by a wing on the midrib; callus elongated below the articulation, slender, acuminate, arcuate, pointed; first glume wanting; second glume and sterile lemma equal, thin, prominently 3-nerved, hoodshaped, enclosing the fruit, appressed-hispid between the nerves; fruit indurate, oblong, brown at maturity, minutely striate, the margins of the lemma tightly enclosing the palea, not inrolled.

Annuals with conduplicate blades and two to several sub-digitate, slender, ascending or spreading racemes.

Centrochloa singularis Swallen, sp. nov.

Annua; culmi erecti, 10–75 cm. alti, glabri, ramosi; vaginae compressae, carinatae, glabrae vel margine papilloso-pilosae; ligula truncata, 0.5 mm. longa; laminae conduplicatae, glabrae, 5–15 cm longae, 3–8 mm. latae, suprema valde reducta; racemi 2–7, 3–14 cm. longi, rachi 0.5 mm. lata, marginibus scabris; spiculae 3.5–4 mm. longae; gluma secunda et lemma sterile 3-nervia, inter nervos dense hispida, pilis glumae secundae quam spiculis longioribus, pilis lemmatos sterilis quam spiculis brevioribus; lemma fertile 2–2.3 mm. longum, viride vel fuscum, apice minute hispidum.

Annual; culms 10–75 cm. tall, mostly single, sometimes 2 or 3, erect, glabrous, branching at all the nodes, the branches enclosed in the sheaths until after maturity of the primary panicle; sheaths compressed-keeled, glabrous or sparsely papillose-pilose on the margins, the lower ones short, overlapping, the two upper elongate but shorter than the internodes; ligule truncate, 0.5 mm. long; blades conduplicate, arcuate, ascending to spreading, glabrous, 5–15 cm. long, 3–8 mm. wide, or smaller in depauperate specimens, the uppermost blade much reduced; racemes 2–7, 3–14 cm. long, the rachis narrowly winged, 0.5 mm. wide, glabrous, the margins scabrous; spikelets obconic, 3.5–4 mm. long, the pedicel very short; second glume and sterile lemma equal, covering the fruit, prominently 3-nerved, appressed-hispid between the nerves, glabrous at the summit, the hairs golden or purple, those on the second glume exceeding the spikelet, those on the sterile lemma shorter than the spikelet, at maturity becoming purplish-black, clustered into stiff points standing away from the spikelet, appearing like a tiny crown; fruit 2–2.3 mm. long, oblong, striate, minutely hispid at the tip, pale green, turning chestnut brown at maturity.

Type in the U. S. National Herbarium no. 1,611,707, collected in open, sandy places between Barra do Corda and Grajahú, Maranhão, Brazil, March 4, 1934, by Jason R. Swallen (no. 3703).

Open sterile sandy land, northeastern Brazil.

MARANHÃO: Between Barra do Corda and Grajahú, *Swallen* 3703, 3704; between Carolina and Riachão, *Swallen* 4006, 4008, 4021.

GOYAZ: Philadelphia, *Swallen* 3921.

Centrochloa is closely related to the monotypic genus *Spheneria*.[2] These two genera apparently present a case of parallel development, the first from *Axonopus* since the spikelets are placed with the back of the fruit turned away from the rachis, and the second from *Paspalum* since the back of the fruit is turned toward the rachis. In both *Spheneria* and *Centrochloa*, the spikelets readily disarticulate from the pedicel, the articulation in the first being long and oblique and in the second small and round. Furthermore, the spikelets of *Spheneria* are not spurred as are those of *Centrochloa*, and the base of the fruit is long acuminate, while that of *Centrochloa* is blunt as in *Axonopus*.

[2] *Spheneria* Kuhlm. Comm Linhas Telegraph Estrat Matto Grosso 67: 57. 1922. Based on a single species *S. setifolia* (Doell) Kuhlm.
Spheneria kegelii Pilger, Repert. Sp Nov. Fedde 26: 228 1929 Based on *Paspalum kegelii* C. Muell.
Paspalum kegelii C Muell. Bot. Zeit. 19: 324 1861. "Surinam, in arenosis prope Mariepaston Majo 1846. Kegel (Coll. no. 1316)."
Paspalum setifolium Doell in Mart. Fl. Bras. 2[2]: 61. 1877. "Habitat in regione Amazonica prope Manaos (Spruce n 884 et 1360) "
Spheneria setifolia Kuhlm Comm Linhas Telegraph Estrat. Matto Grosso 67: 57. 1922 Based on *Paspalum setifolium* Doell.

BOTANY.—*New species of the genus* Dimorphandra *Schott section* Pocillum *Tul.*[1] ADOLPHE DUCKE, Jardim Botanico, Rio de Janeiro. (Communicated by E. P. KILLIP.)

The genus *Dimorphandra* may be divided into two sections: *Eudimorphandra* and *Pocillum*, which are so natural that it would perhaps be better to consider them as subgenera. They are chiefly distinguished by the fruits, and each has a different geographical distribution. The species of *Eudimorphandra* occur throughout the Amazonian hylaea inclusive of Guiana and in tropical Brazil as far south as Rio de Janeiro and the State of S. Paulo. *Pocillum*, however, is strictly limited to the hylaea.

This latter section now contains 15 species, 10 of which are found in the Brazilian states of Pará and Amazonas, and 5 in British Guiana. One of them, *D. macrostachya* of the slopes of Mount Roraima must be included in the flora of both countries, as well as in that of Amazonian Venezuela. Here occurs also the Brazilian *D. pennigera*. The sole species found in French Guiana, *D. polyandra*, is, according to Sandwith, probably an anomalous form of *D. hohenkerkii* of British Guiana. *D. pennigera*, collected in the Brazilian and Venezuelan Upper Rio Negro, must certainly exist in the neighbouring Colombian territories, and *D. gigantea* grows at the frontier of Peru.

[1] Received January 17, 1934.

The habitat of the majority of the species is the upland forest with moist sandy soil, having a surface layer of acid black humus. Here the red-flowered species may be counted among the most elegant and showy trees. Some species, however, are small trees of dry savannas (in Brazil, *campinas*) of white sand. None of them was found in the periodically overflooded Amazonian lowlands.

I have examined herbarium samples of 9 Brazilian and one British Guiana species (*D. congestiflora*, cotype, received from Kew Gardens.) For the four or five remaining species, I am content with the good descriptions in Sandwith's review[2] of the British Guiana *Dimorphandra*. The type specimens of the new species described below are preserved in the Jardim Botanico of Rio de Janeiro; cotypes or duplicates of all species I collected have been distributed to the United States National Museum and to the principal botanical institutions of Europe. Cotypes of *D. gigantea* have been sent to Yale University School of Forestry, accompanied by a wood sample.

KEY TO THE SPECIES OF DIMORPHANDRA SECTION POCILLUM

A—Laminae of the staminodes coherent in the bud, forming a hood-like piece, deciduous at the opening of the flower.

Staminodes anantherous. Flowers relatively large, distinctly pedicellate, white, later becoming yellowish or dirty reddish.

Pinnae 13–21-jugate, leaflets 21–48-jugate. Racemes very long. Amazonian estuary and environs; Rio Trombetas.
D. velutina Ducke.

Pinnae 6–10-jugate, leaflets 20–30-jugate. Racemes shorter. Rio Negro, Cassiquiare and environs of Roraima.
D. pennigera Tul.

Pinnae 1–2-jugate, leaflets 4–8-jugate. Racemes shorter than those of the first species. Manáos.
D. vernicosa Benth

Staminodes with a rudimentary anther. Flowers pedicellate. Pinnae 9–12-jugate; leaflets 20–40-jugate. Not seen. British Guiana.
D. cuprea Sprague & Sandw.

B—Staminodes free.

Staminodes anantherous. Flowers pedicellate, white; petals sericeous-pilose within. Pinnae 2-jugate; leaflets 3–5-jugate, large for this genus. Not seen. British Guiana.
D. davisii Sprague & Sandw.

[2] Kew Bull. Misc. Inf. 1932: 395. 1932.

Staminodes with a rudimentary anther. Petals glabrous within.

Pinnae 1–3-jugate; leaflets 4–7-jugate, fairly large. Flowers pedicellate red. Manáos.

D. ignea sp. nov.

Pinnae 3–5-jugate; leaflets 7–12-jugate, smaller. Flowers pedicellate, red. Plants not seen.

Fertile stamens 5. British Guiana.

D. hohenkerkii Sprague & Sandw.

Fertile stamens 8–10 (perhaps anomalous?). French Guiana.

D. polyandra R. Ben.

Pinnae 3–10-jugate; leaflets 10–33-jugate, small Flowers sessile.

Leaflets nearly glabrous. Spikes very long and thin, flowers fire-red; calyx distinctly pubescent. Eastern part of the State of Pará.

D. glabrifolia sp. nov.

Lower surface of leaflets sericeous-pubescent Spikes very long and thin; flowers orange-red; calyx distinctly pubescent. British Guiana.

D. congestiflora Sprague & Sandw

Lower surface of leaflets red brown, ciliolate. Spikes shorter but thicker; flowers of a palish orange color; calyx nearly glabrous. Northwestern part of the State of Pará.

D. campinarum Ducke

Pinnae 11–17-jugate; leaflets 22–33-jugate, small. Flowers subsessile (pedicel about 0.5 mm. long), red. Manáos.

D. coccinea sp nov.

Pinnae 13–22-jugate; leaflets 30–54-jugate, very small Flowers orange-ferruginous, subsessile (pedicel about 0.5 mm.). Indumentum of young branchlets, petioles, peduncles, etc., relatively thin, tomentous. Rio Curicuriary tributary of the Upper Rio Negro.

D. ferruginea sp nov.

Pinnae 18–17-jugate, leaflets 32–54-jugate, very small Indumentum of young branchlets, petioles, peduncles, etc , velvet; leaflets nearly glabrous. Tabatinga.

D. gigantea sp. nov

C—Incompletely known species, of the affinity of *pennigera* according to Bentham. Laminae of the staminodes deciduous, unknown. Pinnae 6–12-jugate; leaflets 17–25-jugate, small. Flowers pedicellate, red (according to Schomburgk). Not seen Environs of Roraima.

D. macrostachya Benth

Dimorphandra ignea Ducke, sp. nov.

Arbor 20–35-metralis ramulis foliisque novellis et inflorescentiis tenuiter canoferrugineo-tomentellis. Folia petiolo modice longo, crasso; pinnae 1–3-(saepius 2)-jugae; foliola 4–6-(rarius 7)-juga, brevissime (1–2 mm.) petiolulata, 40–90 mm. longa et 15–45 mm. lata, oblonga vel elliptico-oblonga, basi acuta, apice minime acuminata vel acuta vel obtusa et saepe retusiuscula, coriacea, supra nitida, subtus subopaca et pallidiora, tenuissime penninervia. Racemi 2–7, vulgo 200–300 mm. longi, anthesi plena ad 15 mm. crassi, sat breviter pedunculati, rhachidibus crassis. Flores ignei, numerosissimi, pedicellis 1–1.1/2 mm. longis; calix 1.1/2–2 mm. longus et latus, campanulatus, lobis brevissimis, extus canopuberulus; petala 3–4 mm. longa extus sparsim griseopuberula caeterum glabra; stamina 5, vulgo 4–5.1/2 mm. longa, glabra, petalis longiora; staminodia 5, circa 6 mm. longa, libera, glabra, clavato-spathulata, basi longe stipitata, apice anthera rudimentari coronata; ovarium subsessile dense fulvovillosum. Legumen ut in *D. vernicosa*, sutura superiore fortius bialato-dilatata.

Habitat circa Manáos (civ. Amazonas), sat frequens in silva non inundabili leviter paludosa solo silico-humoso secus rivuli Mindú cursum superiorem et prope cataractam altam fluminis Tarumá ubi 27–5–1932 florifera (leg. A. Ducke, H. J. B. R. no. 23,265).

This new species agrees in the leaves with *D. vernicosa*, but belongs, on account of its flowers, to a very different group of species

Dimorphandra glabrifolia Ducke, sp nov.

Dimorphandra macrostachya Ducke, Archiv. Jard. Bot. Rio de Janeiro 4: 39. 1925, non Benth. 1840.

Arbor magna usque 40 m. alta, rarius mediocris Ramuli novelli, foliorum petioli et rhaches inflorescentiaeque tenuiter cano-vel ferrugineo-tomentosi. Folia vulgo breviter petiolata; pinnae 3–10-jugae; foliola 10–26-juga, sessilia, maiora usque ad 22 mm. longa et 6 mm. lata at saepius 16 mm. longitudine et 4 mm. latitudine non excedentia, apicalia et praesertim basalia gradatim minora, lineari-vel subobovato-lineari-oblonga, basi obliqua apice levissime retusiuscula, margine revoluto, coriacea, supra rugulosa glabra nitida, subtus pallidiora opaca subglabra (pilis minimis sparsis) costa prominente. Spicae 1–6, usque ad 380 mm. longae anthesi plena 10–14 mm. crassae, vulgo breviter pedunculatae, rhachidibus crassis. Flores inodori ignei numerosissimi, sessiles vel subsessiles pedicello 1/2 mm. longo; calix 1–1.1/2 mm. longus, 2–2.1/2 mm. latus, cupularis, breviter dentatus, tenuiter pubescens; petala 3–3.1/2 mm longa, glabra; stamina 5, glabra, 3.1/2–4.1/2 mm. longa; staminodia 5, libera, 4.1/2–5 mm. longa, glabra, longe stipitata laminis clavato-spathulatis apice anthera rudimentari coronatis; ovarium subsessile dense et longe fulvidovillosum. Legumen forma ut in reliquis hujus sectionis speciebus, usque ad 200 mm. longum et ad 90 mm. latum, adultum glabrum, seminibus 14–18 mm. longis, 8–10 mm. latis crasse albuminosis.

Habitat sat frequens in silva non inundabili at plus minus paludosa solo silico-humoso secus rivulos "nigros," in civitatis Pará parte orientali: prope flumen Aramá in aestuario amazonico, H. J. B. R. no. 20,203 (speciei typus); prope Belem do Pará, Herb. Amaz. Mus. Pará no. 2,149 et 16,846; in insula Collares, H. A. M. P. no. 12,651; prope Sao Caetano de Odivellas ad ostium fluvii Pará, H. J. B R. no 11,817; sub radicibus montis Parauaquara inter Prainha et Almeirim, H. J. B. R. no 10,956. Specimina omnia legit A.

Ducke, exceptis no. 2,149 et 11,817 a M. Guedes et P. Le Cointe lectis. Prope Santa Izabel viae ferreae inter Belem et Bragança, et circa Gurupá visa. In horto botanico Rio de Janeiro culta.

This species was erroneously identified as *D. macrostachya* Benth. by Huber and by myself, according to the original diagnosis where the inflorescences are described as spikes and not as racemes; we have distributed it under this name and I have mentioned it under the same name in various papers. Recently, Sandwith[3] in his most valuable revision of the *Mora* and *Dimorphandra* of British Guiana re-established the true identity of *D. macrostachya* and re-described the type. According to the same author, the Pará species is a very different plant, closely allied to *D. congestiflora* Sprague et Sandw.; this latter, however, has the under surface of the leaflets densely yellowish-sericeous. The leaflets of the numerous specimens of the Pará plant vary considerably in their dimensions, but are constantly glabrous or subglabrous; their lower surface is scarcely paler than the upper, and not sericeous.

Dimorphandra coccinea Ducke, sp. nov.

Arbor mediocris vel magna, ramulis junioribus, foliorum petiolis et rhachidibus inflorescentiisque canotomentellis. Folia petiolo sat longo et robusto; pinnae 12–16 (rarissime 11-vel 17)-jugae, foliola 22–33-juga, sessilia, 7–11 mm. longa et 2–4 mm. lata (basalia et apicalia gradatim breviora), lineari-oblonga, basi obliqua et auriculata, apice retusiuscula, coriacea, supra nitida saepe rugulosa, subtus pallidiora costa prominente et margine revoluto puberula, adulta caeterum subglabra. Spicae 2–7 rarissime 1, vulgo 280–380 mm. longae anthesi plena 12–16 mm crassae, longiuscule pedunculatae rhachidibus crassis. Flores laete coccinei numerosissimi, subsessiles vel vix ad 1/2 mm. pedicellati; calix circa 1 1/2–2 mm. longus et parum magis latus, cupuliformis lobis brevissimis latis, minime puberulus; petala 3–4 mm. longa extus minime griseopuberula caeterum glabra, stamina 5, glabra, 4–5 mm. longa; staminodia 5, libera, glabra, ad 6 1/2 mm. longa laminis clavato-spathulatis longe stipitatis apice anthera rudimentari coronatis; ovarium subsessile dense et longe fulvidovillosum. Legumina vidi in arbore, forma ut in reliquis hujus sectionis speciebus.

Habitat circa urbem Manáos (civ. Amazonas) sat rara in silva non inundabili solo silico-humoso secus rivulos, locis Cachoeira Grande, Estrada do Tarumá et Colonia dos Francezes, loco ultimo florifera 20-8-1931, legit A. Ducke, H. J. B. R. no. 23,968.

Allied to *D. glabrifolia*, but with very elegant multipinnate and multijugate leaves The flowering tree is of a remarkable beauty.

Dimorphandra ferruginea Ducke, sp nov

Arbor parva vel vix mediocris como ampla umbelliformi, ramulis novellis, foliorum petiolis et rhachibus inflorescentiisque tenuiter et brevissime canoferrugineo-tomentosis Folia sat longe petiolata; pinnae 13–22-jugae; foliola 30–54-juga, sessilia, maiora usque ad 5 mm. longa et ad 1 mm lata (basalia et praesertim apicalia minora), lineari-oblonga parum falcata, basi parum obliqua subauriculata, apice subtruncata minime retusiuscula margine revo-

[3] Kew Bull. Misc Inf 1932: 395 406 1932

luto, coriacea, supra nitida saepe rugulosa glabra, subtus opaca sat dense pilosa costa prominente dense ferrugineovillosa. Racemi 1–5, vulgo 300–400 mm. longi, anthesi plena 12–14 mm. crassi, longiuscule pedunculati rhachidibus crassis. Flores anthesi incipiente dilute aurantiaci demum ferruginei, numerosissimi, pedicellis anthesi circa 1/2 mm. demum 1 mm. longis; calix 1–1.1/2 mm. longus, 2–2.2/3 mm. latus cupuliformis breviter dentatus, extus ferrugineo-puberulus; petala 3–3.1/2 mm. longa, glabra; stamina 5 glabra, 4–5 mm. longa; staminodia 5 libera, ad 6 mm. longa, glabra, laminis clavato-spathulatis longe stipitatis, apice anthera rudimentari coronatis. Ovarium dense et longe fulvovillosum. Legumen ignotum.

Ad ripas saxosas et arenosas fluminis Curicuriary, Rio Negro superioris affluentis (civ. Amazonas), 26-12-1931 flor., leg. A. Ducke, H. J. B. R. no. 23,969.

Allied to *D. campinarum* in the structure and color of the flowers, but differing in the much more numerous pinnae and leaflets.

Dimorphandra gigantea Ducke, sp. nov.

Arbor 50-metralis et forsan altior, trunco basi radicibus tabularibus alte emersis. Ramuli novelli, petioli, pedunculi rhachidesque foliorum et inflorescentiarum pilis densis rufis subvilloso-velutini. Foliorum petiolus sat longus, validus; pinnae 18–27-jugae; foliola 32–50-juga, maiora 7 mm. longa vix ultra 1 mm. lata (basalia et apicalia semper minora), sessilia, lineari-oblonga leviter falcata, basi truncata parum obliqua subauriculata, apice obtusa vel acutiuscula, margine non revoluto, subcoriacea, supra glabra parum nitida, subtus pallida opaca subglabra costa minime pilosula. Racemi 7–14, in speciminibus nostris juveniles, usque ad 300 mm. longi, longe longe (usque 130 mm.) pedunculati, tenues rachidibus crassis. Flores solum in alabastris novissimis adsunt, subsessiles (anthesi forsan breviter pedicellati), numerosissimi, canopilosuli, petalis nondum e calice exsertis, staminibus fertilibus 5 glabris, staminodiis jam bene evolutis 5 liberis glabris lamina anthera rudimentari coronata, ovario fulvidovilloso. Leguminis valvas putredine plus minus destructas vidi sub arbore, iis speciei *D. velutina* similes

Habitat in silva non inundabili prope Tabatinga (ad civitatis Amazonas fines occidentales), leg. A. Ducke 28-9-1931 cum ligno no. 22, H. J. B. R. no. 23,789

One of the tallest trees of the forest near Tabatinga. At first glance it suggests, in its indument and leaves, *D. velutina*, a species with hood-like anantherous coherent staminode-laminae. The proposed species is fairly closely allied to *D. ferruginea*, but is at once distinguished from that species by its size and by the velvety indument of the young branchlets, which form a contrast with the nearly glabrous leaflets. The flowers I have collected, but their color is not apparent.

SCIENTIFIC NOTES AND NEWS

Prepared by Science Service

NOTES

Last Winter's Weather.—A survey of the winter of 1934–35 by the U. S. Weather Bureau shows that the season was warmer than usual over almost the entire United States. Between 85 and 90 per cent of the country had super-normal temperatures for the months of December, January and February. Lower-than-average temperatures ruled in a limited area in the Northeast, and along a narrow Atlantic coast strip the records show a just-about-average winter. This warm-winter trend has now lasted for nearly twenty years.

February in particular was warmer and drier than average. This was especially the case in the Northwest. For example, at Bismark, N D., only one February in the past sixty years has been warmer than the month just closed. Eleven of the past twelve Februaries in that region have been warmer than normal, and the average temperature for all twelve has been ten degress above the normal for the month.

Weather observers in the mountain areas of the West, where summer irrigation must depend on snows of the preceding winter, reported encouraging conditions at the end of winter. In the mountains of the Pacific Coast states especially the snow packs were deep and heavy, and on the whole much greater than last year's; at the same time the water already in the soil was more abundant Farther east, in the Great Basin and Rocky Mountain regions, soil water was not so nearly up to standard, due to cumulative drought of several years, but the snow supplies on the upper slopes were encouragingly large.

National Bureau of Standards—New knowledge of propeller vibration and the possible causes of why propellers break in midair is reported by Dr WALTER RAMBERG, PAUL S. BALLIF and MACK J. WEST. Such propeller failures, while rare compared with the number of propellers in service, usually have serious consequences. Often the flying broken parts rip through the wings of a plane, cause a wreck and sometimes loss of life.

Because it was almost hopeless to try to measure the size of propeller vibrations and the forces in blades while they were whirling rapidly, the government scientists produced a comparable effect by working backward.

Instead of the propeller receiving its vibrations during actual flight the experimental test was performed with a fixed propeller made to undergo the vibrations by having its propeller shaft twisted back and forth mechanically. Thus strains and stresses similar to those encountered during normal operation were set up and could be measured. It was found the vibrations were those of resonance wherein tiny forces, timed at just the right period, built up and amplified one another until the total effect was enough to snap the blade. For the experimental propellers two vibration periods were found; one at the frequency of 35 times a second and the other 130 times a second. For the lower frequency of vibration it was found that the greatest stresses occurred at the middle of the propeller blade.

Smithsonian Institution.—Iroquois murderers were compelled by tribal code to remain on the scene of the crime until discovered, J. N. B HEWITT of the Bureau of American Ethnology has learned in his studies of the cus-

toms of the Iroquoian tribes. When found by the relatives of the deceased, the criminal might either be killed on the spot, or he might be haled before the tribal council and payment of blood-money be arranged by his relatives. The latter procedure was the one more usually adopted.

Children's Bureau, U. S. Department of Labor.—The large number of deaths of American mothers in childbirth as compared with mothers in other countries cannot be explained away by laying the blame on methods of reporting, it appears from a study conducted by Dr. ELIZABETH C. TANDY.

"The official figure of the United States, which in the last few years has exceeded that of every country except Scotland, remains high no matter what method of assignment is used," Dr. Tandy states.

Differences in methods of assigning causes of deaths are not enough to explain the high maternal mortality rate in the United States, as compared with foreign countries. Even if the method of the country assigning the smallest proportion of deaths to the puerperal state were in use in the United States, the United States figure would still exceed that of all 16 countries included in the study, except Australia, Canada, Chile and Scotland.

Lack of exact knowledge of the antirachitic effect of foods fortified with vitamin D, especially the so-called vitamin-D milk which is now being prepared by three different methods and widely distributed, has made it imperative to work out a method by which the relative merit for infant feeding of these various milks could be determined and comparisons made with standard substances such as cod-liver oil and viosterol containing vitamin D. The children's Bureau through its division of child and maternal health, is now carrying on, in preparation for future studies of vitamin-D milks, a series of clinical tests of the antirachitic value of cod-liver oil and viosterol. These substances are provided for the purpose by the Food and Drug Administration of the Department of Agriculture, which carries out the biological assays for vitamin D. Assistance and advice are being given by the Senior Chemist of the Bureau of Chemistry and Soils of the Department of Agriculture

NEWS BRIEFS

The recently organized Washington Chapter of the Society for Experimental Biology and Medicine held its first scientific meeting at the Cosmos Club on February 25 The officers of the chapter are: president, Dr. VINCENT DU VIGNEAUD; secretary, MISS SARAH BRANHAM.

PERSONAL ITEMS

Dr. ISAIAH BOWMAN, director of the American Geographical Society, chairman of the National Research Council, and director of the Science Advisory Board, has been elected president of the Johns Hopkins University.

Prof. ROBERT F. GRIGGS of George Washington University lectured on *Dionaea* before the Royal Canadian Institute, Ottawa, on the evening of March 16.

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PHYSICS.—*What is electricity?*[1,2] PAUL R. HEYL, National Bureau of Standards.

I trust that there is no one so optimistic as to suppose that because I have asked this question I am going to answer it, nor so pessimistic as to fear that because I have asked a question which I cannot answer I can offer you nothing but platitudes. I believe it possible in this case to avoid both Scylla and Charybdis.

This question, said the late Professor John Trowbridge[3] of Harvard University, is often asked as though it were capable of a short and lucid answer which might be understood by any person of liberal education. Many answers have been given, but it is interesting to note that the more definite and confident the answer the older it is, and that as we ascend the ladder of time toward the present day such answers as we encounter are less definite and more cautious.

It will be interesting to review, perhaps rather briefly, the ideas which have been held at various times as to the nature of electricity, and then, looking over the wealth of physical discovery which has been amassed in the past forty years, to endeavor to select from it such facts as may be of importance in guiding and controlling future speculation on this question; for though such speculation has been at a minimum, if not a stand-still, during the twentieth century, it will doubtless revive again. Speculation, or as it has been otherwise termed: "apt conjecture, followed by careful verification," has been behind much of the advance of science. Such was the method of Faraday and of Darwin. The conjectures of the ancients, having little in the way of observed fact to guide them, might range far and wide, and had small heuristic value, but with the growth of experiment the range of conjecture has continually narrowed and its value as an aid to further progress has steadily increased.

[1] Publication approved by the Director of the National Bureau of Standards of the U.S. Department of Commerce. Received March 30, 1935.

[2] This is the fifth of the Joseph Henry Lectures of the Philosophical Society presented March 30, 1935, in honor of the first president of the Philosophical Society.

[3] TROWBRIDGE. *What is electricity?* London: Kegan Paul, Trench, Trubner and Co. 1897.

The beginning of our knowledge of electricity is lost in the mists of antiquity. What we can recover of it is excellently told by Park Benjamin in his history: *The intellectual rise in electricity.*[4] It is customary to credit Thales (600 B.C.) with the first observation of the attractive power of rubbed amber, but Benjamin shows that amber was widely known among the ancients for centuries before Thales. Beads of amber have been found in the ancient lake dwellings of Europe, in the royal tombs at Mycenae (2000 B.C.) and throughout northern Italy. The identity in chemical composition of these relics with the amber of the Baltic sea coast is significant of the esteem in which this substance was held and of the distance over which it was thought worth while to bring it. The golden glow of the polished beads suggested the beaming sun, called by Homer ἠλέκτωρ, which doubtless gave rise to the Greek name for amber, ἤλεκτρον.

It is incredible, as Benjamin points out, that this widespread acquaintance of the ancients with amber should have existed so long without its electrical property being often noticed. It is probable that Thales but shared the knowledge of his time in this respect, for his acquaintance with the things of Nature in general was such as to enable him to make the first recorded prediction of an eclipse of the sun. Thales left no writings of his own, and all we know of him we have learned from those who lived several centuries later.

It appears from these authorities that the ancients regarded electricity as a soul or spirit resident in an otherwise lifeless substance. This was in harmony with the prevailing thought of the times, which regarded all motion as evidence of life. The air was inanimate, but the wind was the breath of Aeolus; the waves of the sea were excited by the wrathful strokes of Neptune's trident; the lightning was the thunderbolt of Zeus. This animistic explanation of the nature of electricity was simple and definite enough to be understood by any one, and lasted for several millenniums, in fact until the revival of learning and the growth of experimental science supplied material upon which to base a rival theory.

We are helped to realize this animistic point of view when we read in a translator's footnote to Gilbert's book on *The Magnet*[5] that a certain ancient physician recommended the administration of doses of powdered lodestone in cases of estrangement between husbands and wives. Given the premises of the time, such a conclusion was perfectly logical. It was obvious that the patients exhibited a defi-

[4] London Longmans, Green and Co 1895

[5] Translation by P Fleury Mottelay New York John Wiley and Sons, 1893, p 56

ciency of a certain spiritual element which was found in the lodestone, and the administration of that medicine followed as naturally as a modern prescription of cod liver oil because of its vitamin content.

It was the middle of the sixteenth century before the next answer on record was given to the question: *What is electricity?* This answer came from Cardan,[6] whose name is familiar to mathematicians (perhaps more so than it deserves to be). Cardan was the originator of the fluid theory of electricity which held the stage in one form or another for over three centuries, and survives to-day in popular parlance in the term *the electric fluid* or, still more colloquially, *the juice.* Cardan passed from the spiritual to the material in his explanation, which was that amber "has a fatty and glutinous humor which, being emitted, the dry object desiring to absorb it is moved towards its source, like fire to its pasture; and since the amber is strongly rubbed, it draws the more because of its heat."[7]

In this last sentence we see the influence of Cardan's profession. He was, among other things, a physician, and was accustomed to warm the cupping glass in drawing blood from his patients. The laws of pneumatics were not yet understood at that time, and it was generally supposed that the cupping glass acted because of its heat.

The fact that this *fatty and glutinous humor* was intangible and invisible seems to have caused Cardan no embarrassment. We may perhaps view this the more charitably when we think of the contradictory attributes that later scientists have found it convenient to assign to the luminiferous ether.

The year 1551 in which Cardan published this theory may be taken as marking the end of the first era, in which electricity was regarded as a soul or spirit. Its beginning goes back beyond recorded history.

The concept of electricity as a material substance contained in certain bodies known as electrics was strengthened by the experiments of Gilbert (1600), who showed that many substances besides amber were to be included in this class, but the full development of the fluid theory of electricity did not come until the middle of the eighteenth century. In the meantime, von Guericke (1672) had invented his sulphur globe electrical machine, which made electrical experimentation easy on a large scale. With the facilities thus placed at his disposal he discovered electrical conduction and electrostatic repulsion, the latter destined to be a phenomenon of prime importance in later speculation on the nature of electricity.

[6] CARDAN. *De subtilitate*, lib XXI, Paris 1551

[7] PARK BENJAMIN, op cit. p 248.

In the eighteenth century development of the fluid theory two names are prominent, those of Du Fay and Franklin, each typifying a separate trend in theory.

Du Fay's experiments (1733 and later) chronologically preceded those of Franklin. His most important discovery was that glass when rubbed behaved in one respect quite differently from amber; a bit of gold leaf excited by contact with the glass tube is then repelled by the glass but attracted by excited amber. "And this," said Du Fay, "leads me to conclude that there are perhaps two different electricities." These he distinguished accordingly as vitreous and resinous, and laid down the law that like electricities repeal each other and unlike attract.

To explain the same phenomenon Franklin (1747) postulated a single electric fluid of which all bodies were normally full. If a body acquired more than this normal amount he called it *plus*, or positively electrified, and if its charge was less than normal, *minus*, or negatively electrified.

Franklin's hypothesis had simplicity in its favor; it required one less assumption than that of Du Fay. In this respect it obeyed more closely the rule laid down by Newton: "We are to admit no more causes of natural things, than such as are both true and sufficient to explain their appearances . . . for Nature is pleas'd with simplicity and affects not the pomp of superfluous causes."[8]

This simplicity of Franklin's hypothesis, added to the reputation which he himself rapidly attained in scientific circles, gave the one-fluid theory an advantage over its competitor for the time being, but a serious theoretical objection was soon raised against it. Since on this theory a negative charge meant a deficiency of electric fluid, there must be a limiting value of negative charge, namely when the body is completely emptied of the electric fluid; but two such bodies, both being negatively charged, should repel each other—and why?

There was much hesitancy on the part of the one-fluid advocates about pushing this argument to its logical conclusion. It remained for a bold German named Aepinus (1759) to seize the bull by the horns and assert that matter devoid of electricity is self-repellent.

This doctrine came as a shock to a generation many of whom could remember Newton. It was useless to point out that Newton had deduced the law of gravitation by observation of bodies that possessed their normal amount of electricity, and that the behavior of matter with the maximum negative charge was something which no

[8] NEWTON. *Principia*, Book III: *Rules of reasoning in philosophy*

one had ever observed. The one-fluid theory had received a serious jolt from which it never recovered; this argument was used against it as late as the 1830's. The attention of theoretical physicists of the eighteenth century was turned toward the two-fluid theory, and during the closing years of that century and the early part of the nineteenth the work of Coulomb, Laplace, Biot and Poisson produced an elaborate and elegant mathematical theory which so well described all the electrostatic phenomena then known that by 1830 the two-fluid theory was generally accepted.

But it often happens that as soon as one theory is comfortably settled on the throne another rises up to challenge its supremacy. We shall see the reign of each successive theory of electricity growing shorter. The thousands of years of the first era were followed by three centuries of the second. In the first half of the nineteenth century great things were happening. In 1820 Oersted had discovered that an electric current could produce a magnetic effect, thus tying together what had previously been regarded as separate phenomena. In 1822 Seebeck showed that electricity could be generated by heat. These discoveries impressed themselves on the mind of Faraday, then at work in the Royal Institution. He was familiar with the work of Davy in producing chemical decomposition by electricity, and the converse phenomenon of Volta, the production of electricity by chemical action. Faraday was also aware of the converse of Seebeck's discovery, the production of heat (and light) in the electric arc, and his thoughts turned naturally toward the undiscovered converse of the Oersted effect. He says himself at a later time[9] (1845):

> "I have long held an opinion, almost amounting to conviction, in common I believe with many other lovers of natural knowledge, that the various forms under which the forces of matter are made manifest have one common origin; or, in other words, are so directly related and mutually dependent, that they are convertible, as it were, into one another, and possess equivalents of power in their action In modern times the proofs of their convertibility have been accumulated to a very considerable extent, and a commencement made of the determination of their equivalent forces "

Such were the considerations which led Faraday to attempt the generation of electricity by means of a magnet (1831). The story is familiar to all of us; how he placed a magnet in a helix of wire and found that no current was produced except momentarily while the magnet was being placed in or taken out of the coil. This discovery seems to have made quite an impression in other than scientific circles, as is evidenced by some verse which has come down to us:

[9] FARADAY. *Experimental researches in electricity*, 3: 1 London, 1855

"Around the magnet, Faraday
Is sure that Volta's lightnings play.
To bring them out was his desire.
He took a lesson from the heart;
'Tis when we meet, 'tis when we part,
Breaks forth the hid electric fire."

Encouraged by this success, Faraday later (1845) sought and found a correlation between magnetism and light. Twenty years later this in its turn furnished the inspiration for Maxwell's electromagnetic theory, by means of which the domain of optics was annexed to that of electricity.

The publication of Maxwell's paper in 1865 may be considered as closing the second era of electrical theory, that in which electricity was regarded as a material fluid, and the opening of the third era in which the concept of electricity assumed a less material and more elusive form.

Bv 1865 the two great doctrines of nineteenth century physics, the conservation of energy and the correlation of physical forces (as foreshadowed by Faraday) had been enunciated and were well on the way to general acceptance. During the seventies and early eighties, electricity, in common with heat and light, was sometimes called, in the phrase of the day, *a mode of motion*, which meant a form of energy.

The adoption of this view was, of course, a matter of slow growth. Maxwell's electromagnetic theory had a long struggle for acceptance, so long, in fact, that Maxwell himself did not live to see its final triumph. He died in 1879, and it was not until 1886, when Hertz produced experimentally the electromagnetic waves which Maxwell's theory demanded, that its acceptance may be said to have become complete.

Against this concept of electricity as a *mode of motion*, that is to say, a form of energy, Lodge[10] in 1889 entered a protest. He pointed out that water or air under pressure or in motion represents energy, but that we do not therefore deny them to be forms of matter. He emphasized an important distinction between two terms: *electrification*, which is truly a form of energy, as it can be created and destroyed by an act of work, and *electricity*, of which none is ever created or destroyed, it being simply moved and strained like matter. No one, said Lodge, ever exhibited a trace of positive electricity without there being somewhere in its immediate neighborhood an equal quantity of the negative variety.

[10] LODGE. *Modern views of electricity*, p 7 London, Macmillan and Co, 1889.

Lodge did much to crystallize the ideas of the time concerning the nature of electricity. These ideas, since Maxwell's merger of optics with electricity, had been, as Lodge pointed out, not clearly defined, but in general the idea was that electricity was in some way a phenomenon of the ether. Lodge enlarged upon this idea, explaining electrostatic phenomena as due to ether stress, electric currents as ether flow and magnetism as ether vortices. Electricity, which had been previously regarded as a material fluid, now became an immaterial one, and in consequence this third period of electrical theory may be called the ethereal era.

As we mount toward the present time we see the different eras of electrical theory rapidly shortening in duration. While the spiritual era lasted several milleniums and the fluid theory three centuries, the ethereal era lasted only a few decades. The fourth era is that which is still with us. It may be called the atomic or quantum period, in which it is noteworthy that but little attention has been paid to the ultimate nature of electricity and a great deal to its structure. It is difficult to say when this period began, as, in fact, the ethereal era began to die almost as soon as it began to live.

Wilhelm Weber,[11] in 1871, in developing his theory of magnetism, pictured to himself light positive charges rotating about heavy negative ones, much like a satellite about a planet; and in 1874 Johnstone Stoney read before Section A of the British Association a paper entitled: *The physical units of nature*, which was not printed until seven years later.[12] In this paper he asserted the atomic nature of electricity and made a rough calculation of the elementary charge on the basis of Faraday's law of electrolysis. Ten years later[13] he was the first to use the term *electron*.

Helmholtz,[14] in his Faraday lecture at the Royal Institution in 1881, further developed this line of thought, saying (p. 290). "Now the most startling result of Faraday's law is perhaps this. If we accept the hypothesis that the elementary substances are composed of atoms, we cannot avoid concluding that electricity also, positive as well as negative, is divided into definite elementary portions, which behave like atoms of electricity."

Maxwell himself saw that his electromagnetic theory was essentially continuous in its nature, and recognized the difficulty arising from the implications of Faraday's experiments. In his *Treatise on*

[11] MILLIKAN *The Electron* (2nd edition) p 20. University of Chicago Press 1924.
[12] STONEY Phil Mag 11: 381–390 1881
[13] STONEY Sci Trans Royal Dublin Society, 11th series, IV: 563 1891
[14] HELMHOLTZ. Journ Chem Soc (London) 39: 277–304 1881

electricity and magnetism (1: 813. Chap. IV. 1873), in the chapter on electrolysis he says: "It is extremely improbable that when we come to understand the true nature of electrolysis we shall retain in any form the theory of molecular charges."

For Helmholtz, however, the atomic nature of electricity was beyond question. Electricity, as he saw it, was a special chemical element[15] whose atoms combine with those of other elements to form ions. Moreover, it appeared to be a monovalent element, for it seemed that a monovalent element combined with one electron, a bivalent one with two, and so on, exactly as a chlorine atom combines with one atom of hydrogen and an oxygen atom with two atoms of hydrogen. Helium, with its zero valence and double electrical charge, was as yet unknown.

The inevitable process of reconciliation of these contradictory theories was early begun by Lorentz,[16] who suggested for this purpose his electron theory of electricity. On this theory all the effects of electricity inside bodies were explained on the assumption of electrons, and all the effects of electricity at a distance, electrostatic, electromagnetic and inductive, required the help of the ether. To unite these two classes of phenomena he assumed that each electron was closely bound up with the ether, and that any change in configuration of the electrons produced a change in the ether which was propagated with the velocity of light, and thus produced action at a distance.

About this time an entirely new line of experimental research was developing which was destined eventually to make the atomic concept of electricity dominant for a time. This was the study of the electric discharge in high vacua. Several workers had investigated this field without attracting much notice, but it remained for Crookes to direct widespread attention to this class of phenomena by an exhibition of novel and beautiful effects in vacuum tubes which he gave at the meeting of the British Association at Sheffield in 1879. Crookes unquestioningly assumed these effects to be due to electrified molecules of residual gas in the tube. It was shown later by others (J. J. Thomson, Townsend, Wilson, Millikan) that the negatively charged particles in a Crookes tube were not molecules or even atoms, but bodies of a minuteness previously unknown, about the 1/1800th part of a hydrogen atom in mass, and bearing a definite negative

[15] GRAETZ. *Recent Developments in Atomic Theory* London, Methuen and Co 1923

[16] LORENTZ Verslagen en Mededeelingen der Koninklijke Akademie van Wetenschappen, Amsterdam, 8: 323 327 1891. Also Archives Neérlandaises, 25: p 432, Chap IV. 1892.

charge of electricity. For these tiny bodies the term electron, introduced by Stoney, was revived. Still later work brought to light the proton, with an equivalent positive charge but larger mass than the electron and, in our own day, the positive electron.

As the result of this new line of investigation it became clear that a great many electrical phenomena required the atomic theory of electricity for their explanation. A great many, but not all; for a large number refused to fall in line under a corpuscular explanation, but could be simply and completely explained on Maxwell's theory as ether disturbances. The discovery by Hertz of the electromagnetic waves predicted by Maxwell did much to swing the pendulum back in this direction. The reconciliation of these contending views has been carried on much along the line originally taken by Lorentz. It is of interest to note that his idea of an electron inseparably bound up with the ether is found today in all essentials in the theory of wave mechanics.

We have now brought this somewhat hurried survey of electrical history up to the present day. We have seen that past speculations as to the nature of electricity fall into four classes, each corresponding to an era of thought. In the first of these eras, beginning probably with the earliest observations of electrical attraction, and terminating in the middle of the sixteenth century, electricity was regarded as a soul or spirit. The second era may be said to have been opened by Cardan in 1551 and closed by Maxwell in 1865. During these three centuries electricity was regarded as a material fluid of one or two kinds. It is worthy of note that during this period the concept of the electrical fluid showed a trend toward the immaterial, from Cardan's *fatty and glutinous humor* to the impalpable and imponderable fluid of the early nineteenth century. In the third era electricity in its various manifestations was regarded as some kind of an ether disturbance of a continuous nature. The fourth concept emphasized the atomic or discontinuous structure of electricity without any suggestion as to the ultimate nature of these atoms.

But though speculation as to the ultimate nature of electricity has been in abeyance since the opening of the twentieth century it will certainly arise again, and within limits it is well that it should. We may therefore turn now to an examination of the wealth of material which the last forty years have placed at our disposal and see what it may contain that is likely to be of importance in guiding and suggesting future speculation as to the nature of electricity.

The emphasis laid by the twentieth century on the structure rather

than the nature of electricity is natural, for structure is much more easily determined than nature, and moreover a knowledge of the first is likely to give us some useful hints as to the second. It appears that the discontinuous structure of electricity goes almost hand in hand with that of matter. A tabular view of the known elementary particles of matter with their associated charges of electricity will be useful.

CHARGE		+	−	0
MASS	HEAVY	PROTON		NEUTRON
MASS	LIGHT	+ ELECTRON	− ELECTRON	(NEUTRINO)

The heavy particles now known, the proton and the neutron, have a mass equal to that of a hydrogen atom; the light particles have about 1/1800 of this mass. The light neutral particle has not yet been discovered, but so urgent is the demand for it in current nuclear theory that it has been named before its advent.

According to the idea that has prevailed for two centuries, positive and negative electricity should be merely reflected images of each other, their properties being equal and opposite. The behavior of the negative electron and the proton shows nothing inconsistent with this concept as far as electrical properties go. On the discovery of the positive electron it was at first thought that it was shorter lived, or as a chemist might say, more reactive than its negative counterpart, but this has not been borne out by subsequent investigation.[17] The mass associated with the positive charge in this case has been investigated by several persons. The latest work is that of E. Rupp[18] who finds that the mass is within five per cent of that of the negative electron. Rupp appears to have found one point of difference between the two which, if confirmed, will be of importance.

It has been found that the passage of negative electrons through thin films of metal is accompanied by a diffraction effect, photographs of the electron beam after transmission showing a series of concentric rings. Rupp passed negative and positive electrons through the same films of gold and aluminum, and found that while the negative particles gave the usual rings the positive particles showed a continuous scattering. We will return to the interpretation of this later.

As to the neutron, it is still uncertain whether it is a proton which has acquired a negative electron or whether it is to be regarded as an independent entity without electric charge. The latter, as we shall

[17] Allowing for relative abundance

[18] RUPP Physikal Zeit 35: 999 1934 But in Zeit f Physik 93: 278 1935, Rupp has withdrawn his earlier article for further verification

see later, would be in serious conflict with present accepted electrical theory.

There was a time, not so very long ago, when the atom of matter was considered to be its ultimate structural unit. The discovery of the proton and the electron gave meaning to the term *sub-atomic*. With this in mind, the question naturally arises as to a possible further subdivision of the electron. Several observers have claimed to have found evidence of smaller charges than that carried by the electron, but Millikan,[19] after an exhaustive discussion of the subject, came to the conclusion that up to 1924 there had been adduced no satisfactory evidence of this smaller charge.

In the early years of the present century there was some discussion as to whether the electron was to be regarded in shape as a rigid sphere (Abraham) or as contractile. The latter hypothesis was advanced by Lorentz to explain the negative result of the Michelson-Morely experiment. Lorentz supposed the electron, by motion through the ether, to flatten into an oblate spheroid. Experiments by Bucherer[20] in 1909 were interpreted as favoring the hypothesis of Lorentz.

But in 1927 a new line of experimental evidence as to the structure of the electron was opened up by Davisson and Germer,[21] soon followed by G. P. Thomson.[22] These investigators found in brief, that electrons (of the negative variety) might be scattered by reflection or diffracted by passage through very thin films of metal in such a way as to suggest that an electron is at least as much like a little bunch of waves as it is like a particle, and that neither aspect can be ignored.

This is well brought out by G. P. Thomson's diffraction rings. The electron must have a wave aspect, or there would be no interference pattern; it must have a charged particle aspect, or the whole ring system would not be deflected by a magnet, as it is found to be. The whole situation, in fact, had been foreshadowed theoretically by the wave mechanics of de Broglie and Schrodinger.

A number of explanations have been offered for this dual behavior. Perhaps the most completely worked out is that of J. J. Thomson,[23] based upon the diffraction rings obtained by his son, which lend themselves particularly well to theoretical treatment. On this view the electron is associated with and accompanied by a group of waves

[19] *The electron*, Chap. VIII
[20] BUCHERER Annalen der Physik 28: 513, 29: 1063. 1909
[21] DAVISSON and GERMER Phys Rev 30: 705 1927
[22] G P THOMSON Proc. Roy Soc. 117: 600 1928
[23] J J. THOMSON *Beyond the electron* Cambridge University Press. 1928; Phil. Mag 6: 1254 1928.

which guide and direct its motion. Now it was found by a study of the speed of the electrons and the associated wave lengths in the diffraction rings that a curious and complicated relation existed between these quantities. If u is the velocity of an electron and λ its associated wave length, this relation is:

$$\frac{u\lambda}{\sqrt{1-u^2/c^2}} = C \qquad (1)$$

in which c is the velocity of light and C is a constant.

But this, as J. J. Thomson shows, is exactly the relation that should hold for the group speed of electromagnetic waves in a medium such as the Kennelly-Heaviside layer, containing a multitude of electric charges, positive and negative.

J. J. Thomson therefore suggests the following structure for the negative electron:

I. A nucleus which, like the older concept of the electron, is a charge of negative electricity concentrated in a small sphere.

II. This nucleus does not constitute the whole of the electron. Surrounding it there is a structure of much larger dimensions which may be called the sphere of the electron. This sphere contains an equal number of positive and negative charges, forming a little Kennelly-Heaviside layer around the nucleus. Measurements on the diffraction rings indicate a diameter for this sphere at least 10,000 times that previously accepted as the diameter of the electron.

III. The nucleus is the center of a group of waves and moves with the group speed in its atmosphere of electric charges.

At the time that J. J. Thomson proposed this hypothesis the positive electron was not known. Here comes in the importance of Rupp's work[16] previously referred to. On their face, these experiments indicate either that the train of waves that accompanies a negative electron is absent from the positive electron, or that all possible wave lengths are present.

Just as the atom, once regarded as an ultimate structural unit, is now recognized as a complex of electrons, protons, neutrons and possibly neutrinos, so the electron, it seems, must be regarded as a similar complex. Much more, doubtless, is to be learned about its structure before we can hope to answer the question: *What is electricity?*

Perhaps the most outstanding fact in modern physical theory is the dominant position occupied by electricity. In the nineteenth century one spoke of matter and electricity as two separate and in-

dependent entities; nowadays electricity has become the fundamental entity of which matter is merely an aspect. Matter, once supreme, has lost its individuality and has become merely an electrical phenomenon which electricity may exhibit more or less according to circumstances.

It is obvious that our answer to the question: *What is electricity?* will be fundamentally influenced according to whether we hold an electrical theory of matter or a material theory of electricity. It will therefore be worth our while to examine the foundation for the present view that electricity, whatever it may be, is the sole world-stuff. So radical has been this change in our thinking that it would seem a foregone conclusion that it must be based upon the clearest and most unequivocal of experimental evidence.

This change in our concepts did not come suddenly. Its beginning dates back to 1893, when J. J. Thomson[24] showed on theoretical grounds that a charged sphere in motion through the ether would encounter a resistance which to all intents and purposes would appear as an increase in the sphere's inertia, i.e., in its mass. Calculation indicated that this effect would become appreciable only if the velocity of the charged body was comparable to that of light.

In 1893 this suggestion was of academic interest only, no bodies moving with sufficient speed being then available for experiment. A few years later conditions had changed. The study of radioactive substances and of the discharge of electricity through gases had placed at our disposal positively and negatively charged particles moving with unprecedented speeds, which in the case of the negative particles were in some cases comparable with the speed of light. Here, it would seem, was an opportunity to test Thomson's theory of increasing mass.

Unfortunately, the conditions of the problem were such that it was not at first possible to obtain a measure of the mass of such a particle, but only a determination of the ratio of the electric charge to the mass which carried it (e/m).

Kaufmann[25] found, however, that for the swifter particles this ratio was less than for the slower ones. There were only two ways of explaining this fact, both equally radical: either the mass increased or the charge diminished as the speed of the particle became greater.

In this dilemma opinion inclined generally to the first alternative,

[24] J. J. Thomson. *Recent researches in electricity and magnetism*, p. 21. Oxford, Clarendon Press. 1893.
[25] Kaufmann. Gesell. Wiss Göttingen, Nov. 8, 1901; July 26, 1902; March 7, 1903.

largely because there was in existence a theoretical reason to expect it, while no one as yet had been ingenious enough to suggest any reason why a moving charge should alter. It is of importance to note that Kaufmann's experimental result, because of its equivocal character, cannot be accepted as more than half proving J. J. Thomson's theory.

Kaufman calculated that such particles as he experimented with might have, when moving slowly, an *electrical mass* equal to about one fourth their total mass. In making this calculation he assumed that a particle behaved as though it were a little metallic conductor, but he was careful to point out that a different assumption might lead to another result.

J. J. Thomson, on the assumption that a particle had no metallic conductivity, but acted like a point charge, found that Kaufmann's results indicated that the whole of the mass of the particle might be accounted for electrically.

This was the origin of the electrical theory of matter. Its pedigree goes back to J. J. Thomson's theory, which in turn was derived from the electromagnetic theory of Maxwell. Kaufmann's experiments only half proved Thomson's theory, which in addition was complicated by a special assumption with regard to the distribution of the charge on the particle. Without this assumption only a part of the mass could be accounted for electrically.

But much water has run under the bridge since 1893. Forty years is a long life for any physical theory in these days, and the recent discovery of the neutron has brought with it a challenge to the electrical theory of matter.

In J. J. Thomson's original theory of the increase in mass of a moving charge it was an essential point that the lines of force should be free to adjust themselves as the motion demanded. As a leaf or a card tends to flutter down through the air broadside on, so the lines of force, originally distributed radially and symmetrically about the charge at rest, will tend to set themselves in a plane perpendicular to the direction of motion of the charge. They will not all be able to lie in this plane because of their mutual repulsion, but the density of the lines will be a maximum in this plane and a minimum in the direction of motion, and a certain space distribution will result, of such a nature that the apparent increase of mass can be completely accounted for.

But it is essential for this result that the lines of force shall be perfectly free at their outer ends; in other words, only a single isolated

charge is considered. Now in a structure like the hydrogen atom, composed of a negative and a positive particle, there is bound to be some interference with this freedom of adjustment. In a neutral, non-ionized atom it would appear that all of the lines must begin and end within the atomic structure.

J. J. Thomson must be given credit for foreseeing this difficulty, though the Bohr atom was as yet years in the future. He had an atomic concept of his own in mind at that early date, and pointed out that the distance between the particles constituting an atom must be thousands of times the diameter of a particle. In consequence, he said, almost all of the mass will originate where the lines have their greatest density, near each particle; and the particles are relatively so far from each other that the parts of the lines of force in their immediate neighborhood will have almost perfect freedom of orientation with the motion of the atom.[26]

This is a quantitative question; but it is clear that only under the most favorable conditions will we have a freedom of motion in the atom which approximates that around an isolated charge, and in consequence the electrical explanation of matter, on J. J. Thomson's theory, must be in the same degree approximate.

With the neutron, conditions are more rigid. Assuming the neutron to consist of a proton and a negative electron, the union of these must be almost as close as possible, as the neutron, on modern theory, may form a constituent of an atomic nucleus. Here we are dealing not with atomic magnitudes but with sub-atomic dimensions, which is quite another thing. Freedom of motion of the lines of force in such a structure must be almost non-existent. And if we make the alternative assumption that the neutron is an independent, non-electrical entity, the electrical theory of matter must admit of an important exception.

But an electrical theory of matter to be acceptable must admit of no exceptions. It must obey the *all or none principle*. If it is approximate in even the slightest degree, we are confronted with the existence of two kinds of matter, ordinary and electrical, and we are violating the rule of simplicity in reasoning laid down by Newton.

But has there not been later evidence supporting this theory?

It has sometimes been said that Millikan's oil-drop experiments, by which he measured the charge on a single electron, prove the constancy of this charge, and hence the variability of the mass alone in Kaufmann's experiments. It is true that Millikan found that the charge on an ion *after it had been transferred to the oil-drop* was the

[26] J. J. THOMSON *Electricity and matter*, p 51 New York Scribner's 1904.

same whatever the source of the original charge. Ions of different gases, unquestionably of different speeds, gave the same charge to the drop. But it is to be remembered that the measurement of this charge was made, not at the speed of the ion, but at that of the oil-drop, which was of the order of a few hundredths of a centimeter per second.

The special theory of relativity is sometimes quoted in support of the constant charge and variable mass. It is true that Einstein[27] in his original paper of 1905 gives a formula for the change of mass with the speed of a moving electron, which, like J. J. Thomson's formula, becomes infinite at the speed of light, and that he gives no similar formula for a change in the charge. It will be interesting for us to see how he obtained this result.

In section 10 of his paper Einstein derives the following formula for the x-component of the acceleration of a moving charged particle, together with formulas for the other components:

$$\frac{d^2x}{dt^2} = \frac{e}{m}\frac{1}{\beta^3}X$$

in which e is the charge on the particle, m its rest mass, X the component of the electric vector and β the familiar $1\sqrt{1-v^2/c^2}$.

It is evident that the quantity e/m is altered by the factor $1/\beta^3$, but whether the charge or the mass or both are changed is not obvious. Einstein without comment assumes e to be constant and m to bear the full effect of the modifying factor, and on this basis derives his formula for the change of mass.

This assumption, of course, was orthodox in 1905, but it is of interest to note that as a matter of logic the electrical theory of matter can claim no supporting evidence from the special theory of relativity.

On the basis of this result of Einstein's, Sommerfeld[28] introduced a modification into Bohr's theory of the atom. On Bohr's theory the hydrogen atom was regarded as consisting of a negative electron revolving in a Keplerian ellipse around a positively charged nucleus, the attraction between the two charges being balanced by the centrifugal force of the revolving electron. Sommerfeld (page 45) makes the orthodox assumption that the electrical charges remain constant, but that the mass of the revolving electron varies with its speed according to Einstein's formula. In consequence the mass of the electron fluctuates as it describes its orbit, being greatest at perihelion and least

[27] EINSTEIN Ann d Physik 17: 891 1905.
[28] SOMMERFELD. Ann. d. Physik 51: 1. 1916.

at aphelion, and its centrifugal force will vary slightly from that in a non-relativistic Keplerian ellipse. Because of this the orbit becomes an ellipse with a moving perihelion, like that of the planet Mercury. The effect of this will be to split up the spectral lines, producing what Sommerfeld called the relativistic fine structure.

This predicted effect has actually been found in the spectra of hydrogen and helium, the number of the component lines and their relative separation being in accordance with theory.

As to the value of this result as a confirmation of the electrical theory of matter, it is to be observed that Sommerfeld would have obtained exactly the same modification of the Keplerian ellipse if he had assumed the charge to decrease and the mass to remain constant, thereby disturbing the balance by reducing the centripetal attraction instead of increasing the centrifugal force.

The logic of the whole situation is that the electrical theory of matter can claim no independent support from Millikan, Einstein or Sommerfeld. It rests for the present on J. J. Thomson's theory, and even this theory assumes tacitly that the charge is unaltered by the motion. It is remarkable that every one we have mentioned, from J. J. Thomson onward, when confronted with the necessity of making a choice, prefers to keep the charge constant and let the mass take the consequences, and this without comment or apology.

Of course, there must be a reason for this; and although it is explicitly stated by no writer that I have seen, the reason is doubtless to be found in a fundamental law of electricity, that of the conservation of electrical charge, with its corollary, the exact equivalence of positive and negative electricity. This law states that no one has ever produced the slightest trace of a positive charge without the simultaneous production of an equal and opposite negative charge somewhere in the neighborhood.

This law has been the subject of some very searching experiments. We may operate within a large conducting cube, such as was built by Faraday at the Royal Institution; perform within it all the usual electrical experiments, excite a glass tube by rubbing it with fur, draw sparks from an electrical machine, and yet a sensitive gold leaf electroscope connected to the cube will remain undisturbed. It seems impossible to create or destroy an electric charge without a compensating creation or destruction of an equivalent charge of the opposite sign.

And yet the era of thought which has not hesitated to question the conservation of energy can hardly be expected to respect this elec-

trical principle; and in fact this law has been brought under fire from several quarters. If these points of order are sustained they will have an important bearing on future answers to the question: *What is electricity?*

It is well to remember in this connection that all the experiments upon which is based the law of conservation of electric charge have started with neutral bodies. The glass tube and the fur were at first neutral, but exhibited equal and opposite charges after being rubbed together; the electrical machine was at first neutral, but on being operated its two sides became equally and oppositely charged.

Suppose a chemist should announce that as a result of the analysis of several thousand neutral salts he had come to the conclusion that acid and basic radicals existed in equal amounts in nature; we would likely think him ignorant of such syntheses as that of the acid radical cyanogen (CN) from its elements in the electric arc. But is there any known electrical analogue of such a synthesis or its reverse dissociation? No, nothing that we have so far been able to produce in the laboratory; yet if we imagine some race of children of the gods who could play with planets as we with pith balls, something of this kind might come to their notice.

Among the phenomena of atmospheric electricity there is an unsolved mystery. Many fruitless attempts have been made to explain it consistently with the principle of conservation of electrical charge. Continual failure has led more than one physicist to look for the explanation in a slight departure from this principle, and it has been shown that a departure so slight as to be beyond laboratory detection would yet, on the large scale, solve this mystery. The difficulty in question is to account for the negative charge of the earth.

Our earth is not a neutral body. Its entire surface is negatively charged to such an amount that there exists near the surface a potential gradient of 150 volts per meter. The conductivity of the atmosphere is small, but not zero; and because of this conductivity and the potential gradient there is a continual conduction of negative electricity away from the earth amounting, over the whole surface of the earth, to a current of about 1000 amperes. Small as this may appear, it is sufficient to bring about a loss of 90 per cent of the earth's charge in ten minutes if there were no means of replenishing the loss. The nature of this replenishment is the mystery referred to.

So great has been the difficulty of accounting for this replenishment that in 1916 G. C. Simpson,[29] now Director of the British

[29] G. C Simpson. Monthly Weather Review 44: 121. 1916.

Meteorological Office, raised the question of a possible spontaneous production of a negative charge in the earth's interior, but offered no suggestion as to how this could be brought into line with existing theory.

In 1926 Swann,[30] who had worked unsuccessfully with the same problem, followed Simpson's lead, but chose the other alternative of a slight annihilation, or as he called it, death of positive electricity. He was able to bring this into connection with existing electrical theory by generalizing Maxwell's equations. His fundamental idea was that there might be a very slight difference in the properties and behavior of the two electricities. Here again we are reminded of the difference apparently found by Rupp.

Such a suggestion was not without precedent. Lorentz[31] in 1900 had postulated a difference between the attraction of unlike charges and the repulsion of like charges to account for another mystery—gravitation. It must be admitted that the accepted idea of the absolute equivalence and mirror-image character of the two electricities had weakened somewhat when such men as the Director of the British Meteorological Office, the Director of the Bartol Research Foundation and a Nobel prizeman could join in expressing doubt of its accuracy.[32]

Swann's theory of the maintenance of the earth's charge is, from the theoretical point of view, the most successful that has yet been advanced. He modifies the equations of Maxwell by introducing two small terms, amounting respectively to one part in 10^{26} and five parts in 10^{19} of the main term of the classical theory. These additional terms involve the acceleration and time rate of change of positive charge.

Swann assumed no similar terms for the negative charge, his idea being that there is a slight differential effect in behavior. For simplicity, therefore, he introduced a differential term applying only to positive electricity. This assumption enabled him to account for a slow death of positive electricity due to the centripetal acceleration produced by the earth's rotation.

To account for the known electrical facts, there is necessary an annihilation of less than one proton per cc per day, equivalent to a loss of 0.5 per cent of the earth's mass in 10^{20} years. This would also account for as much of the earth's magnetic field as is symmetrical

[30] SWANN. Jour. Frank. Inst. 201: 143. 1926. Phil. Mag 3: 1088. 1927.

[31] LORENTZ. Koninklijke Akademie van Wetenschappen te Amsterdam, Proceedings of the Section of Sciences 2: 559. 1900.

[32] Additional references MORE. Phil Mag. 21, 196. 1911 GLEICH Ann. d Physik 83: 247. 1927. W ANDERSON. Ibid 85: 404. 1928 A PRESS Phil. Mag. 14: 758. 1932.

about the earth's axis, and would give the correct ratio for the magnetic fields of the earth and the sun. Moreover no development of charge or magnetic field could be detected with a sphere of laboratory size rotating at the highest practicable speed. And finally, Swann's scheme is consistent with the special theory of relativity.

Whatever may be thought of Swann's fundamental assumption, it must be admitted that his theory is experiment-proof. Moreover, even though it should be definitely disproved, it would have the lasting merit of impressing upon us caution in extrapolating laboratory results to the cosmic scale.

The relations of newly discovered fact and existing theory are, as we have seen in this somewhat brief survey, rich in suggestion. Speculation is not dead, but sleeping. If the past is still an indication of the future, it will awake again to renewed activity, and when this occurs we will need a wide acquaintance with fact and a good sense of perspective to guide and direct future speculation on the question: *What is electricity?*

CHEMISTRY.—*3, 4-Dimethoxy-5-chlorocinnamic acid and some of its esters.*[1] RAYMOND M. HANN, Laboratory of J. P. Wetherill, Washington, D. C. (Communicated by GEORGE S. JAMIESON.)

The present communication reports the extension of the study of derivatives of 5-chloroveratric aldehyde (3, 4-dimethoxy-5-chlorobenzaldehyde) to include the synthesis of 3, 4-dimethoxy-5-chlorocinnamic acid. The new acid was prepared by condensation of the aldehyde with malonic acid in the presence of pyridine and piperidine according to the Knoevenagel reaction, the intermediate 3, 4-dimethoxy-5-chlorobenzalmalonic acid losing carbon dioxide during the reaction process to yield the desired substituted cinnamic acid. The acid was characterized by preparation of several of its esters.

EXPERIMENTAL

3, 4-Dimethoxy-5-chlorocinnamic acid.—A solution of 10 grams of 5-chloroveratric aldehyde and 13 g of malonic acid in 10 cc of pyridine was treated with 5 drops of piperidine and heated for one and one-half hours on the steam bath under a reflux, carbon dioxide being copiously evolved. The reaction was completed by refluxing for 15 minutes, the reaction mixture cooled, and treated with 15 cc of concentrated hydrochloric acid in 85 cc of water. The precipitated yellow

[1] Received February 18, 1935.

oil rapidly solidified, and after standing overnight in the ice box it was filtered and dried. Yield 12.0 g, quantitative.

The acid may be recrystallized from water or 50% ethyl alcohol, separating in ball-like clusters of gelatinous needles, but it is preferable to dissolve it in 10 parts of ether, then concentrate to about half volume, when upon standing it separates in colorless glistening prisms melting at 126–7° C (corr.) to a clear oil.

Anal. Calcd. for $C_{11}H_{11}O_4Cl$: C, 54.4; H, 4.6. Neutralization equivalent, 242. Found: C, 54.2; H, 4.7. Neutralization equivalent, 241.

Methyl 3, 4-dimethoxy-5-chlorocinnamate.—One g of 3, 4-dimethoxy-5-chlorocinnamic acid, 10 cc of absolute methyl alcohol and 1 cc of concentrated sulfuric acid were refluxed for four hours, the solution cooled, and the ester precipitated as an oil by addition of 50 cc of water. On standing it crystallized, and upon recrystallization from 10 parts of 80% methyl alcohol was obtained in colorless needles melting at 63° C (corr.). Yield 2.0 g, 95% of theory.

Anal. Calcd. for $C_{12}H_{13}O_4Cl$: Cl, 13.8. Saponification equivalent, 256. Found: Cl, 13.8. Saponification equivalent, 251.

Ethyl 3, 4-dimethoxy-5-chlorocinnamate.—The ethyl ester was obtained by the general procedure used for the methyl homologue. It crystallizes from 50% alcohol in colorless glistening prisms melting at 165° C (corr.) to a clear colorless oil.

Anal. Calcd. for $C_{13}H_{15}O_4Cl$: Cl, 13.1. Saponification equivalent, 271. Found: Cl, 13.0. Saponification equivalent, 265.

Phenacyl 3, 4-dimethoxy-5-chlorocinnamate.—One gram of acid was dissolved in 10 cc of 95% alcohol and titrated with N sodium hydroxide to phenolphthalein alkalinity (4.3 cc), then 0.1 g of acid (to prevent formation of phenacyl alcohol) and 1.0 g of ω-bromo acetophenone in 10 cc 95% alcohol were added and the reaction mixture refluxed for one hour. On cooling the phenacyl ester separated and was recrystallized from 40 cc of 95% alcohol, being obtained in glistening, colorless needles melting at 132° C (corr.).

Anal. Calcd. for $C_{19}H_{17}O_5Cl$: Cl, 9.8. Found: Cl, 10.0.

p-Fluorophenacyl 3, 4-dimethoxy-5-chlorocinnamate.—A solution of the sodium salt of the acid prepared as outlined for the phenacyl ester and 0.7 gram of p-fluoro-ω-chloro acetophenone[2] were refluxed for one hour. The fluorinated phenacyl ester crystallized from alcohol in ball-like clusters of long, colorless needles, and melted at 135° C.

Anal. Calcd. for $C_{19}H_{16}O_5ClF$: Cl, 9.4. Found: Cl, 9.2.

[2] Hann and Wetherill, This JOURNAL, 24: 526. 1934.

p-Chlorophenacyl 3,4-dimethoxy-5-chlorocinnamate.—This ester was prepared by the same general method from p-chloro-ω-bromoacetophenone and crystallized from 40 parts of boiling 95% alcohol in fine, glistening needles melting at 137° C (corr.) to a clear oil.

Anal. Calcd. for $C_{19}H_{16}O_4Cl_2$: Cl, 17.9. Found: Cl, 17.8.

p-Bromophenacyl 3,4-dimethoxy-5-chlorocinnamate.—This ester crystallizes in long, colorless acicular needles melting at 132° C (corr.) to a clear oil.

Anal. Calcd. for $C_{19}H_{16}O_4ClBr$: Saponification equivalent, 439. Found: 437.

SUMMARY

3,4-Dimethoxy-5-chlorocinnamic acid and its methyl, ethyl, phenacyl, p-fluorophenacyl, p-chlorophenacyl, and p-bromophenacyl esters have been synthesized and described.

GEOLOGY.—*Outliers of the Tuscaloosa formation on the western highland rim of Tennessee.*[1] KENDALL E. BORN, Washington University, St. Louis, Mo. (Communicated by ROLAND W. BROWN.)

During the summer of 1933, while mapping the areal geology of Dickson County in the western Highland Rim area of Tennessee, several patches of unrecorded water-worn gravels were noted capping some of the higher hills and interstream areas. These gravels undoubtedly represent remnants of the Tuscaloosa formation of Upper Cretaceous age, which formerly overlay the Highland Rim plateau. The present paper calls attention to these newly recognized occurrences since most of them are farther east than any areas of the formation previously mapped.

The term Tuscaloosa was first applied by Smith and Johnson[2] to the basal Upper Cretaceous deposits in the vicinity of Tuscaloosa, Alabama. In western Alabama and Mississippi the Tuscaloosa, consisting of irregularly bedded clays, sands, and gravels, has an estimated thickness of approximately 1,000 feet. The formation becomes more gravelly toward the north and was formerly considered to thin out in the vicinity of the Alabama-Tennessee line. The presence of this Upper Cretaceous formation on the western Highland Rim was shown by the work of Miser[3] in 1913. Miser determined the age of the

[1] Received January 28, 1935 Published by permission of the State Geologist of Tennessee and the Board of Graduate Studies of Washington University.

[2] SMITH, E A and JOHNSON, L. C. *Tertiary and Cretaceous strata of the Tuscaloosa, Tombigbee, and Alabama rivers.* U S. Geol Survey Bull 43: 95. 1887.

[3] MISER, H. D in DRAKE, N F. *Economic geology of the Waynesboro quadrangle (Tennessee).* Tenn Geol Survey, Resources 4: 107. 1914.

gravels exposed in the Waynesboro quadrangle by tracing the overlying red sands (Eutaw formation) into Hardin County where he found a locality showing Cretaceous fossils.

STRATIGRAPHIC RELATIONS

Deposits of Upper Cretaceous age in Tennessee outcrop in a roughly wedge-shaped area which crosses the State in an approximate north-south direction, the greatest areal distribution of the Upper Cretaceous being west of the Tennessee River. This area is about 70 miles wide along the southern boundary of the State, but narrows until at the Kentucky line it is only about 15 miles in width. In the southern counties bordering the Tennessee River the following stratigraphic and lithologic units of the Upper Cretaceous have been recognized:

	Owl Creek tongue
Ripley formation	McNairy sand member
	Coon Creek tongue
Selma clay	
Eutaw formation	Coffee sand member
	Tombigbee sand member
Tuscaloosa formation	

The Tuscaloosa formation on the western Highland Rim rests unconformably upon Mississippian limestones of Warsaw and St. Louis ages. In the southern counties the Tuscaloosa is overlain by the red micaceous Eutaw sand. In north-central Tennessee the Eutaw is definitely known only as small remnants in Stewart County along the divide between the Tennessee and Cumberland rivers.

LITHOLOGY

The Tuscaloosa formation in Tennessee is represented by well-rounded gravels, consisting essentially of chert with some limestone pebbles. Quartzitic pebbles are not uncommon. In the southwestern corner of the Waynesboro quadrangle Miser[4] noted that the top 30 feet of the Tuscaloosa consisted of "loose gravel, mostly sandstone, quartzite, and quartz in red sand. Quartz pebbles are in greatest abundance." Jewell[5] observed pebbles of quartzite and glassy vein

[4] MISER, H. D. Communication December, 1934

[5] JEWELL, W. B. *Geology and mineral resources of Hardin County, Tennessee.* Tenn. Div. of Geol. Bull. 37: 45. 1931

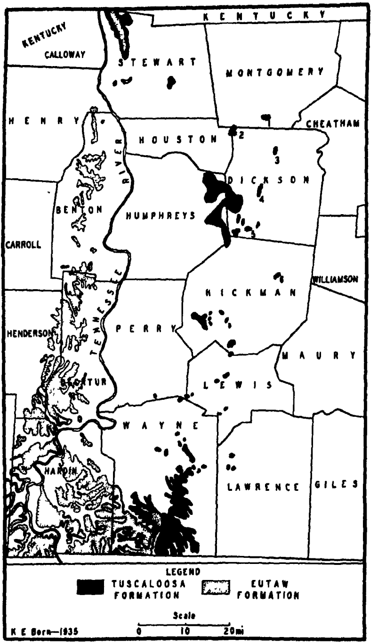


Fig 1.—Sketch map showing exposures of the Tuscaloosa formation on the western Highland Rim of Tennessee The numbers indicate new exposures and refer to descriptions in the text. The size of some of the smaller outliers has been exaggerated.

quartz in southeastern Hardin County. These pebbles have apparently had a distinct origin, but their source is speculative. The writer has noted quartzitic pebbles in exposures of the Tuscaloosa gravel on the northern part of the Rim, but always in rather small amounts.

All of the pebbles show definite evidence of water-wear, some of them closely approximating a sphere in shape. A few are polished. The average diameter is between one and two inches, although diameters of 6 to 12 inches have been observed. The color of the pebbles ranges from almost white to a very dark gray, the majority of them being light gray in color.

Locally, the gravels are intimately associated with sands and clays which generally occur as small lenses and pockets. The amount of sand and clay present decreases to the north. For the most part the constituents are poorly sorted although Jewell[6] observed that the lower portion of the Tuscaloosa in Hardin County was coarser than the top.

The matrix of the gravels consists of finely divided calcareous and siliceous material, much of which is clay. In certain localities, especially in the southern counties of the Rim, hydrous iron oxides have cemented the pebbles into a highly indurated conglomerate.

DISTRIBUTION OF THE TUSCALOOSA FORMATION

Miser[7] found that the Tuscaloosa gravels in the Waynesboro quadrangle were 150 feet thick and covered extensive tracts in the southwestern part of that area. In 1914 Wade[8] mapped the Tuscaloosa formation in Tennessee as far north as Perry and northern Lewis counties. Later he[9] traced remnants of the Tuscaloosa as far north as Trigg County, Kentucky. In 1920 Wade[10] gave a summary of his Upper Cretaceous studies in Tennessee in which the distribution and lithology of the Tuscaloosa formation were discussed. More recently Roberts[11] has described the Tuscaloosa and Eutaw formations of western Kentucky.

Formerly, the Tuscaloosa formation was considered to have a very

[6] JEWELL, W B Op. cit, p 45

[7] MISER, H D *Mineral resources of the Waynesboro quadrangle* Tenn. Geol. Survey Bull 26: 25 1921

[8] WADE, BRUCE *Geology of Perry County and vicinity.* Tenn Geol Survey, Resources 4: 173 1914.

[9] WADE, BRUCE. *The occurrence of the Tuscaloosa formation as far north as Kentucky* Johns Hopkins Univ. Circ 3: 102–106. 1917

[10] WADE, BRUCE. *Recent studies of the Upper Cretaceous of Tennessee.* Tenn Geol Survey Bull. 23: 51-64. 1920.

[11] ROBERTS, J K. *The Tuscaloosa formation in Kentucky* Amer Jour. Sci. 14: 465–472. 1927; *Cretaceous deposits of Trigg, Lyon, and Livingston counties, Kentucky.* Kentucky Geol. Survey 31: 281-326. 1929.

limited areal distribution east of the Tennessee River. However, more detailed studies have revealed isolated exposures of the Upper Cretaceous gravel some 30 to 40 miles east of the river. (See Fig. 1.)

An important link in this chain of outlying areas of gravels of Upper Cretaceous age is the gravels and sands in the vicinity of McEwen and Tennessee City on the central part of the western Highland Rim.

Fig. 2.—Exposure of the Tuscaloosa gravels in a new road cut, about 1½ miles east of Tennessee City. Width of the exposure is about 36 inches.

In this region the Tuscaloosa gravels cover several square miles and have a thickness of more than 25 feet. The gravels are well exposed in most of the new highway cuts between Dickson and McEwen. (See Fig. 2.) Just east of McEwen some 30 feet of the gravels are exposed which are underlain by the highly weathered St. Louis limestone and chert.

In 1930, while working on the brown iron ores of the western High-

land Rim, the writer[12] noted the Tuscaloosa gravels capping the higher hills near Louise in southern Montgomery County (1).* This occurrence of the Upper Cretaceous is some 10 miles farther east than any previously recognized in Tennessee.

During the summer of 1933 several more unmapped outliers of the Tuscaloosa gravels were found in Dickson County. In the extreme northwestern corner of the county, about 4½ miles northwest of Slayden, a small area of Cretaceous gravels occur at an altitude of 650–700 feet. This outlier is more or less continuous into southern Montgomery and eastern Houston counties (2).

About three-fourths of a mile south of Cumberland Furnace, in northern Dickson County, some 25 feet of the Tuscaloosa have been exposed by stream erosion near the crest of a ridge (3). In this exposure the gravels are especially well-rounded, light in color, and have been firmly embedded in sand and clay.

At various places along the north-south ridge bordering the road between Pond and the small village of Hortense, Tuscaloosa gravels were observed (4). Since no bed-rock is exposed in this immediate locality, the thickness of the gravels could not be determined.

South and east of the rather extensive outlier of the Tuscaloosa in western Dickson and eastern Humphreys counties, several small remnants of the Upper Cretaceous gravels were noted forming a veneer on some of the higher hills of the interstream area between Garner Creek and Piney River (5). In these localities, the finer sand and clay have been removed leaving the pebbles scattered as a mantle over the upland and embedded in the residual clays.

During the field season of 1934 a small exposure of gravels, very typical of the Tuscaloosa, was observed just north of the old Johnston iron ore pits, about 4 miles south of Wrigley Furnace in Hickman County (6). This is within 15 miles of the Central or Nashville Basin and is the most easterly occurrence of the formation yet discovered.

ORIGIN OF THE TUSCALOOSA FORMATION

The gravels of the Tuscaloosa formation on the western Highland Rim of Tennessee have been derived from Mississippian limestones and cherts. Mississippian fossils are commonly found in the pebbles. The coral, *Lithostrotion canadense*, indicative of the St. Louis limestone, has been observed towards the center of several pebbles.

[12] BORN, K E *The brown iron ores of the western Highland Rim of Tennessee* Jour Tenn Acad Sci 7: 22 1932

* The numbers in parentheses refer to numbers of localities on the map, Fig. 1.

Berry,[13] basing his conclusions on certain resemblances to present deltas, believes that the Tuscaloosa formation in Alabama represents a series of Cretaceous deltas. This interpretation may be correct for Alabama, where the amount of sand and clay is greater and where paleobotanical evidence is present, but in Tennessee, and especially the northern part of the Highland Rim region, the clays and sands become much less abundant and the Tuscaloosa consists of gravel with only subordinate amounts of sand and clay. Roberts[14] noted this same constitution of the Tuscaloosa in Kentucky and he suggested a marine origin of the gravels. Field observations by the writer point toward a similar origin for the Tuscaloosa formation on the western Highland Rim of Tennessee. The Tuscaloosa gravels in this region are believed to be shore gravels deposited through overlap by the advancing Upper Cretaceous sea.

During the late Carboniferous and early and middle Mesozoic time the western Highland Rim is believed to have been a land mass. During this long geologic interval the land suffered erosion and Wade[15] suggested that the general area was a low-lying land. Wells[16] believes the region was reduced to a peneplain. In western Kentucky Sutton[17] has pictured the topography at the beginning of Tuscaloosa time as an irregular land surface in a mature stage of development. In the southwestern part of the western Highland Rim, Miser[18] interpreted the pre-Tuscaloosa topography as an uneven surface on which sink holes and underground channels were common.

As the result of downwarping, the Upper Cretaceous was initiated in the Embayment region by a transgressing sea which rounded the Mississippian limestones and cherts. The eastern limit of the Tuscaloosa sea in Tennessee is not definitely known, but the present recognized distribution of these basal gravels indicates that the sea encroached far upon the western flank of the Nashville arch.

The size and degree of rounding displayed by many of the pebbles appear to warrant a marine rather than a deltaic origin for the Tusca-

[13] BERRY, E. W. *The delta character of the Tuscaloosa formation.* Johns Hopkins Univ. Circ 3: 18–24 1917, *Upper Cretaceous floras of the eastern Gulf region in Tennessee, Mississippi, Alabama, and Georgia* U.S. Geol Survey Prof. Paper 112: 26–30 1919

[14] ROBERTS, J. K. *The Tuscaloosa formation in Kentucky* Amer. Jour. Sci. 14: 470–472. 1927

[15] WADE, BRUCE *Geology of Perry County and vicinity* Tenn Geol. Survey, Resources 4: 176 1914

[16] WELLS, F. G. *Ground water resources of western Tennessee.* U S Geol Survey Water-Supply Paper 656: 22–23 1933.

[17] SUTTON, A H. *A pre-Cretaceous soil horizon in western Kentucky* Amer Jour. Sci 22. 450–451. 1931

[18] MISER, H. D. *Mineral resources of the Waynesboro quadrangle* Tenn. Geol. Survey Bull. 26: 58–59. 1921.

loosa gravels on the western Highland Rim. Although our present knowledge of the Upper Cretaceous geography of this area is meager, it is believed, as suggested above, that the western Highland Rim was then a region of little or moderate relief. Considerable relief must be assumed to account for cobbles, many of which are 5 and 8 inches in diameter, to be washed into deltas. At present we have no basis for the assumption of any great amount of relief during the early Upper Cretaceous in west-middle Tennessee. No large pebbles are known in the present day stream gravels and it is probable that the present relief of the Rim region is greater than that of Cretaceous time. It appears, therefore, more likely that this rounding of Mississippian limestones and cherts has resulted from wave and tidal action of a sea transgressing a deeply weathered land area.

The width of the Tuscaloosa belt in Tennessee is also suggestive of a marine origin for the gravels. Very extensive deltas would be necessary to account for the rather wide distribution of the Tuscaloosa as indicated by the chain of outliers already known, and further detailed study of additional areas on the western Rim will probably reveal other outliers of the Tuscaloosa formation.

In the southern counties of the Rim and in the area west of the Tennessee River, the Tuscaloosa is overlain conformably by the Eutaw sand whose origin is certainly marine. In Hardin County, Jewell[19] has noted sands, similar to those in the Tuscaloosa, intercalated with the gravels and finer sands of the Eutaw formation. Continuous deposition is strongly suggested.

The presence of the Eutaw in Stewart County and in western Kentucky strongly suggests that these sands were deposited by the Upper Cretaceous sea when depth became favorable for the deposition of finer sediments. It is probable that the Selma and Ripley, and perhaps even younger formations, were laid down over a portion of the western Highland Rim.

Since the Tuscaloosa gravels form a basal conglomerate of a transgressing sea, the formation becomes progressively younger from south to north. The gravels in Dickson and Stewart counties are undoubtedly younger than any part of the gravels in northwestern Alabama and northeastern Mississippi. The Eutaw outliers in Stewart County and western Kentucky may be as young as basal Ripley.

The withdrawal of the Cretaceous sea from the Embayment area again subjected the Highland Rim to erosion and during the peneplanation of the late Cretaceous and early Tertiary most of the de-

[19] JEWELL, W. B. Personal communication. August, 1934.

posits of Upper Cretaceous age were removed. The existing patches of the Tuscaloosa and Eutaw in this region represent remnants of these formations which were probably continuous at one time over most or all of the present western Highland Rim.

BOTANY.—*A new species of* Dracaena *from the Department of Petén, Guatemala.*[1] C. L. LUNDELL, University of Michigan. (Communicated by H. H. BARTLETT.)

While collecting in the savanna country of the Department of Petén, Guatemala, in 1933, I discovered a grove of very interesting monocotyledonous trees in Monte Hiltun, a strip of forest separating Sabana Hiltun and Sabana Zotz. The trees were not in flower or fruit so that only sterile material was obtained. The species is apparently referable to the genus *Dracaena.*

Dracaena petenensis, sp. nov.

Arbor solida 6 usque ad 12 m. alta. Caulis 20–30 cm , basi expansa 70–90 cm., diam. Cortex tenuis fissuris irregularibus aliquantulum angustatisque et fastigiis paucis, inaequalibus, acutis, humilibus, griseus fusco-maculatus sub folia circulis griseis, fuscis vel rubris irregulariter circumdatus. Rami pauci, crassi, 15 cm. sub apice 10–15 mm diam. Folia ramorum apice congesta, pendula, minutissime, serrulata glabri, griseo-viridia, 115–140 cm. longa, 18-20 mm. lata, basta dilata, amplexicaulia, integra scariosa, laminis linearibus, supra basin angustatis apice in aciem late setiformem coarctatis

Type in the herbarium of the University of Michigan, *C. L. Lundell 3271*, collected in Monte Hiltun, Department of Petén, Guatemala, May 17, 1933 Cotype deposited in the United States National Herbarium, Washington, D. C.

The characters which distinguish *Dracaena petenensis* are (1) the massive trunk with expanded base, (2) the few, thick branches, and (3) the crowded, pendent, minutely serrulate, linear leaves 115 to 140 cm. long and 18 to 20 mm. wide. The other New World representative of the genus, *Dracaena americana* Donn. Smith, is occasionally encountered in the same region. It is a smaller tree with entire leaves 20 to 30 cm. in length

[1] Received February 7, 1935 Papers from the Department of Botany and the Herbarium of the University of Michigan, No 527

ZOOLOGY.—*The histology of nemic esophagi.* IV. *The esophagus of* Metastrongylus elongatus.[1] B. G. CHITWOOD, Bureau of Animal Industry and M. B. CHITWOOD.

This is the fourth paper of a series[2] dealing with the structure of the

[1] Received November 18, 1934.
[2] CHITWOOD, B. G., and CHITWOOD, M. B. *The histology of nemic esophagi.* I.

esophagi in various groups of nematodes. In this paper, insofar as possible, the same nomenclature for the various nuclei and cells will be used as in the previous papers.

GROSS MORPHOLOGY

The esophagus of *Metastrongylus elongatus* is clavate and may show grossly 3 indistinct regions, an anterior moderately narrow part or corpus, a very slightly narrower part, or isthmus, and a posterior wide part or bulbar region. The length of the esophagi in specimens studied varies from 262μ to 616μ; however, in the description a single specimen with an esophagus 450μ long has been used, since relative positions and lengths are fairly constant. In this specimen the corpus is approximately 162μ long, the isthmus 90μ long, and the bulbar region 198μ long. The dorsal esophageal gland opens into the lumen at the anterior end of the esophagus, while the subventral glands open into the lumen 126μ from the anterior end or 36μ from the posterior end of the corpus The lumen is triradiate throughout the length of the esophagus, in the anterior part of the corpus the ends of the radii are very slightly rounded (Fig. 1b) and the cuticle is thickened.

NUCLEAR DISTRIBUTION

The corpus may be subdivided into 2 regions, a precorpus and a postcorpus, on the basis of nuclear distribution, these regions approximating the parts of the corpus of *Rhabditis*

Precorpus In the anterior part of the corpus, 22 nuclei, comprising 6 radials (r_{1-6}) and 16 nerve cells (n_{1-16}) have been constantly observed In addition to these there are 4 questionable bodies (s_{1-4}), possibly nuclei of nerve cells, and 1 nerve cell nucleus (n_{8x}) which sometimes appears to be distinct and sometimes identical with n_8. The radial nuclei (r_{1-6}) are arranged in a single group of 6, 1 nucleus on each side of each sector 9 to 18μ from the anterior end of the precorpus.

The nerve cell nucleus n_1 is situated slightly to the right of the mediodorsal position, 7μ from the anterior end of the precorpus; n_{2-3} are situated near the center of the subventral sectors at the same level as n_1; n_{4-6} are situated about 15μ from the anterior end, near the center of each sector; n_7 is about 9μ from the anterior end of the precorpus and in the center of the dorsal sector, while n_{8-9} are near the same level as n_7, 1 nucleus in the center of each subventral sector; n_{10} is immediately posterior to n_9, while n_{8x} is immediately posterior to n_8 or possibly identical with n_8; n_{11-13} are approximately 38μ from the anterior end of the precorpus, 1 nucleus near

The esophagus of Rhabdias eustreptos (*MacCallum*, 1921). Zeit f. Zellf u. Micro. Anat. 22: 29–37 1934

Ibid II *The esophagus of* Heterakis gallinae Zeit f Zellf. u Micro Anat. 22: 38-46 1934

Ibid III *The esophagus of* Oesophogostomum dentatum This JOURNAL 24: 557–562. 1934.

the center of each sector; and, finally, n_{14-16} are about 45μ from the anterior end.

The bodies s_{1-4} are near the external surface of the esophagus, s_{1-2} being about 18μ from the anterior end of the precorpus, 1 nucleus near the center of each subventral sector, while s_{3-4} are about 26μ from the anterior end of the precorpus and arranged similar to s_{1-2}.

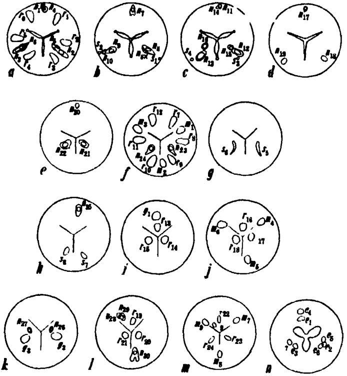


Fig. 1.—Nuclei of esophagus, diagrammatic representation *r, m, s, g, n*, various types of nuclei; *a–c*, nuclei of precorpus; *d–h*, nuclei of postcorpus, *i–j*, nuclei of prevalvar region; *k–m*, nuclei of postvalvar region; *n*, nuclei of esophago-intestinal valve.

Postcorpus. The postcorpus contains 22 nuclei comprising 6 radial nuclei (r_{7-12}), 3 marginal nuclei (m_{1-3}), 9 nerve cell nuclei (n_{17-25}), and 4 nuclei (s_{5-8}), possibly those of nerve cells. The marginal nuclei (m_{1-3}) are arranged as a group of 3, 1 nucleus at the end of each esophageal radius, about 72 to 80μ from the anterior end of the esophagus or about 18 to 26μ from the anterior end of the postcorpus. The radial nuclei (r_{7-12}) are arranged similar to the radials (r_{1-6}) of the precorpus and are about 6 to 12μ posterior to the marginal nuclei.

The nerve cell nuclei consist of 2 groups of 3 nuclei (n_{17-19} and $_{20-22}$), 1 nucleus near the center of each sector, the first group situated approxi-

mately at the anterior end of the postcorpus, and the second group about 6 to 10μ posterior to the first group; a pair of subventral nerve cell nuclei (n_{23-24}) situated about 18 to 25μ from the anterior end of the postcorpus; and a single dorsal nerve cell nucleus (n_{25}) posterior to the orifices of the subventral glands, about 134μ from the anterior end of the corpus or 28μ from the posterior end of the corpus.

In addition to the above, there are 4 nuclei (s_{5-8}) which appear similar to those of nerve cells, but no cell body was observed. The first pair (s_{5-6}) is situated 6 to 10μ posterior to the radials r_{7-12}, 1 nucleus in each subventral sector, while the second pair (r_{7-8}) is near the posterior end of the postcorpus, about 6μ posterior to the last dorsal nerve cell (n_{25})

Isthmus. As indicated by the distribution of nuclei, the isthmus is a region 90μ long between the corpus and the anterior part of the bulbar region, and contains no nuclei

Prevalvar region The anterior part of the bulbar region, the prevalvar region, contains 10 nuclei comprising 6 radial nuclei (r_{13-18}), 3 marginal nuclei (m_{4-6}), and 1 gland cell nucleus (g_1). The radial nuclei are arranged in 2 groups of 3 nuclei each, 1 nucleus of each group near the center of each sector; the first group (r_{13-15}) is about 6 to 12μ from the anterior end of the prevalvar region, while the second group (r_{16-18}) is situated 138 to 150μ from the anterior end of the region The marginal nuclei (m_{4-6}) are arranged like those of the first group (m_{1-3}), and are situated at about the same level as the second group of radials (r_{16-18}) of this region

The dorsal esophageal gland nucleus (g_1) is about half way between the 2 radial groups (r_{13-15} and $_{16-18}$) of this region However, g_1 is quite variable in position, and in other specimens it may be situated further posterior, even at the level of the subventral gland nuclei.

Postvalvar region. The postvalvar region of the esophagus usually contains 16 nuclei as follows: 6 radials (r_{19-24}), 3 marginals (m_{7-9}), 2 gland cell nuclei (g_{2-3}), and 5 nerve cell nuclei (n_{26-30}). In addition to these, 1 more nucleus (s_9), possibly that of a nerve cell, has sometimes been observed The radial nuclei are arranged in 2 groups of 3 nuclei each, 1 nucleus near the center of each sector; the first group (r_{19-21}) is situated 18 to 24μ from the anterior end of the postvalvar region, while the second group (r_{22-24}) is situated at the posterior end of the esophagus The marginal nuclei (m_{7-9}) are arranged like the other margins (m_{1-3} and $_{4-6}$), and situated 6 to 10μ from the posterior end of the esophagus

The subventral esophageal gland nuclei (g_{2-3}) are in the center of their respective sectors, at the anterior end of the postvalvar region *in the particular specimen described here* Sometimes, however, these nuclei are situated in the prevalvar region, 6 to 10μ anterior to the last group of radials of that region (r_{16-18})

The subventral nerve cell nuclei (n_{26-27}) are symmetrically placed, 1 nucleus near the center of each subventral sector, situated at approximately

the anterior end of the postvalvar region; the dorsal nerve cell nuclei (n_{28-29}) are situated just anterior to m_9, with 1 nucleus (n_{28}) anterior to the other (n_{29}); the ventral nerve cell nucleus (n_{30}) is a little to the left of the ventral esophageal radius, 6 to 12μ anterior to m_8. In addition to these nuclei, a right subdorsal nucleus (s_9) was observed in 1 series of sections; it appeared similar to the nucleus of a nerve cell but no cell body was observed.

Esophago-intestinal valve.—The esophago-intestinal valve consists of 2 parts, an anterior part with a trilobed lumen the wall of which contains 3 nuclei, 1 nucleus near the center of each lobe, and a posterior part with a rounded lumen the wall of which contains 4 nuclei, of which 1 nucleus is dorsal, 2 left subventral, and 1 right subventral.

CHARACTER OF NUCLEI

The radial nuclei each contain a moderate sized nucleolus lying in a finely granular, very delicately basophilic nucleoplasm. In cross section the radial nuclei of the corpus (r_{1-12}) are elongated, 7.9μ long by 3.7 to 4μ wide, their long axes corresponding to the radius of the esophagus; those of the prevalvar region (r_{13-18}) are subtriangular, 6.2 to 7μ long by 5 to 5.8μ wide, while those of the postvalvar region (r_{19-24}) are ellipsoidal, 6.2 to 7μ long by 2.9 to 3.3μ wide.

The marginal nuclei are similar to the radial nuclei except that the nucleolus is slightly larger in proportion to the nucleus, and sometimes a second, smaller nucleolus is present. All of the marginal nuclei are ellipsoidal to slightly subtriangular. The nuclei of the first group (m_{1-3}) are about 3.4μ long by 3.3μ wide, those of the second group (m_{4-6}), 7.9μ long by 5μ wide, and those of the third group (m_{7-9}), 4.5μ long by 2.5μ wide.

The gland cell nuclei are the largest nuclei of the esophagus, the dorsal (g_1) 6.2μ long by 6.2μ wide, and the subventrals (g_{2-3}) 7μ long by 8.7μ wide. Each of these nuclei contains a proportionally large nucleolus in a very homogenous, basophilic nucleoplasm.

The nerve cells consist of several types, the nuclei varying greatly in size and character. A brief description of these nuclei may be clarified through reference to figure 4. The dorsal nerve cell nuclei of the corpus are of 3 types, as follows: n_1 is of a type containing a nucleolus in a nucleoplasm which shows no affinity for stain; $n_{4,7,17}$, and $_{26}$ are of a type containing a bilobed, irregular nucleolus, or 2 nucleoli in a nucleoplasm basophilic at the margin; $n_{11,14}$, and $_{20}$ are of a type containing a deeply basophilic nucleoplasm without distinct nucleolus. Of these, n_{26} appears to be a cell of the commissure at the base of the postcorpus, the cell body being large and the cytoplasm homogenous and eosinophilic; n_4 and $_7$ have similar cytoplasm or cell bodies, but are apparently bipolar; the remaining cells have a very small cell body and are spindle shaped and bipolar.

The subventral nerve cells of the corpus contain 2 types of nuclei, $n_{2-3,5-6,15-16,23-24}$ having a nucleoplasm basophilic at the margin, while $n_{8-9,10,12-13}$,

$_{18-19,21-23}$ contain a few basophilic granules but the nucleoplasm is not basophilic at the margin. All of the subventral nerve cell nuclei contain a bilobed nucleus or 2 separate nucleoli; the cells appear to be bipolar and the

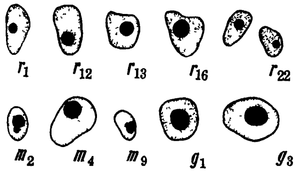


Fig. 2.—Individual nuclei of esophagus. Labelled as in fig. 1.

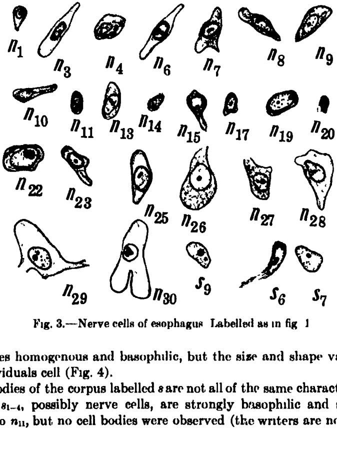


Fig. 3.—Nerve cells of esophagus. Labelled as in fig. 1.

cell bodies homogenous and basophilic, but the size and shape varies with the individuals cell (Fig. 4).

The bodies of the corpus labelled *s* are not all of the same character. Those labelled s_{1-4}, possibly nerve cells, are strongly basophilic and somewhat similar to n_{11}, but no cell bodies were observed (the writers are not entirely

certain that they are nuclei); s_{5-6} are obvious nuclei with lobed nucleoli and clear nucleoplasm, 1 body lying near the inner ventral side of the anterior part of each subventral gland and surrounded by deeply staining cytoplasm, but no cell wall observed; s_{7-8} are similar nuclei situated ventral and medial to the subventral glands. Nuclei in similar positions and of similar character are present in other nematodes, but a comparison of these nuclei will not be taken up until later.

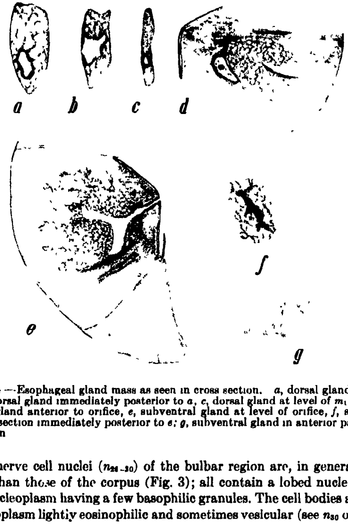


Fig 4.—Esophageal gland mass as seen in cross section. *a*, dorsal gland near orifice; *b*, dorsal gland immediately posterior to *a*, *c*, dorsal gland at level of $m_{1\,1}$; *d*, subventral gland anterior to orifice, *e*, subventral gland at level of orifice, *f*, subventral gland in section immediately posterior to *e*; *g*, subventral gland in anterior part of bulbar region

The nerve cell nuclei (n_{24-30}) of the bulbar region are, in general, larger nuclei than those of the corpus (Fig. 3); all contain a lobed nucleolus in a clear nucleoplasm having a few basophilic granules. The cell bodies are large, the cytoplasm lightly eosinophilic and sometimes vesicular (see n_{30} of Fig. 4). All of these cells appear to be commissural cells; they have 2 chief processes which come off at the same side of the cell body and then diverge. The single s nucleus (s_9) of the bulbar region appears to be similar to the nuclei of the nerve cells of the same region but no cell body has been observed.

ESOPHAGEAL GLANDS

The dorsal esophageal gland has a very short narrow duct lined with cuticle which is continuous with a protoplasmic central tubule having a thick deeply basophilic wall This tubule becomes wider and bifurcates posterior to the orifice of the gland, each branch giving off numerous short branches which are continuous with the coarsely reticulate, deeply basophilic cytoplasm of the gland (Fig. 4a–b). In the anterior part of the precorpus the dorsal gland is rather wide and circumscribed, and occupies a central position in the dorsal sector. In the remainder of the corpus the dorsal gland is narrow (Fig. 4c) and the gland mass finely reticular to alveolate; it becomes a narrow strand in the region of the isthmus, and again larger in the anterior part of the bulbar region. Near the level of its nucleus, the dorsal gland becomes multilobed and occupies a large part of the dorsal sector; in this region the cytoplasm is dense and contains a few alveoli.

The subventral glands extend some distance anterior to their orifices; in this region the cytoplasm is very finely reticulate (Fig 4d). Near the level of their orifices the subventral glands become multilobed but the finely reticular structure remains. Each gland has an extremely short duct lined with cuticle, and continuous with this duct is a thick-walled protoplasmic tube which is immediately multibranched, the branches continuous with the reticulum Posterior to this region the gland mass, like the dorsal gland, becomes smaller until it is finally reduced to a delicate strand of protoplasm in the isthmian region The subventral glands become enlarged in the posterior part of the prevalvar region, become lobed in the region of their nuclei, and then continue to be large and lobed nearly to the base of the esophagus. The protoplasm is dense throughout this region except in the part adjacent to the lumen In general, the mass of the subventral glands is less basophilic than that of the dorsal, and sometimes appears to be very slightly eosinophilic.

ZOOLOGY.—*Development and morphology of the cestode,* Hymenolepis cantaniana, *in coleopteran and avian hosts.*[1] M. F. JONES and J. E. ALICATA, Bureau of Animal Industry. (Communicated by ELOISE B. CRAM).

Previous to the preliminary note by Alicata and Jones[2] in 1933, the life history of the poultry cestode, *Hymenolepis cantaniana*, was unknown. There was reported at that time the finding, in the dung beetle *Ataenius cognatus*, of proliferating larvae which consisted of a mycelium-like structure, numerous buds, and partially or completely de-

[1] Received March 12, 1935

[2] ALICATA, J. E., and JONES, M F. *The dung beetle,* Ataenius cognatus, *as the intermediate host of* Hymenolepis cantaniana Jour. Parasitol. 20: 244. 1933.

veloped cysticercoids (Fig. 1). The larvae developed to maturity in chicks and were identified as *H. cantaniana.* The present paper gives a more detailed account of the development and morphology of the proliferating larva of this cestode in the intermediate host, *Ataenius cognatus.* Since the previous report, 2 additional beetles, *Ataenius stercorator* from Puerto Rico and *Choeridium histeroides* of local origin have been found to harbor similar proliferating larvae, presumably those of *H. cantaniana.* The larvae from *Ataenius stercorator* were collected by Dr. H. L. Van Volkenberg and sent to the Zoological Division for identification, with the statement in a personal communication that this material was identical with that which he reported, but

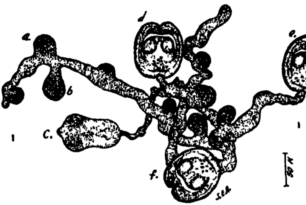


Fig. 1—Larvae of *Hymenolepis cantaniana* from *Ataenius cognatus* Natural infestation *a*, *b*, *c*, developing cysticercoids, *d*, *e* *f*, apparently mature cysticercoids still attached to branching larval tissue After Alicata and Jones, 1933

did not describe in 1931.[3] In the present paper, geographical distribution and seasonal occurrence of the intermediate hosts are discussed briefly. A short description of the adult worm, with data regarding its development, subsequent to laboratory feedings, in the chicken, guinea fowl, and bobwhite quail, also are included.

The authors wish to thank Dr. E. A. Chapin of the U. S. National Museum for identifying beetles and for supplying data regarding distribution of the 3 beetles reported as intermediate hosts.

SOURCE OF LARVAL MATERIAL

The greater part of the cestode larvae available for study occurred as natural infestations in numerous specimens of *Ataenius cognatus;* larvae were observed also in one specimen of *Choeridium histeroides.*

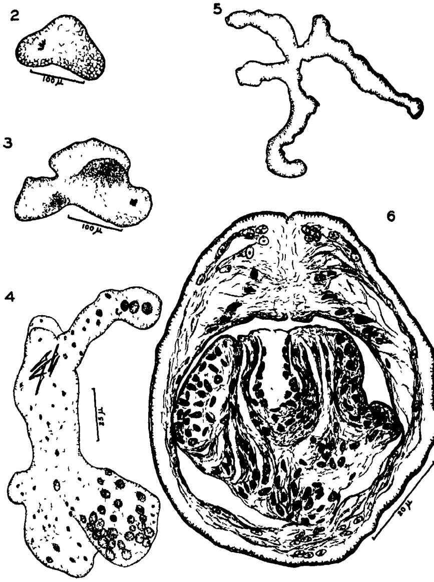
[3] Van Volkenberg, H. L. *Report of parasitologist.* Report Puerto Rico Agric. Exp. Sta. 1930: 38–40. 1931.

These beetles were collected in or near poultry yards, in particular at the Beltsville Research Center of the U. S. Department of Agriculture near Beltsville, Maryland. Three specimens of *Ataenius stercorator*, infested with proliferating larvae, were sent to the Zoological Division from Puerto Rico; the total number of infested beetles of this species, found in that locality by Van Volkenberg, is not known. No laboratory-reared beetles of any of these species were used. A few specimens of *A. cognatus*, after being kept in the laboratory for 2 weeks or longer after collection, were fed eggs of *H. cantaniana* and subsequently harbored young larvae in various stages of development. With one exception, the early stages of development described below were obtained from these experimentally infected beetles. Following experimental feeding, larvae were found in beetles after 24 hours (2 beetles), after 8 days (1 beetle), after 9 to 12 days (1 beetle, fed August 2, 4, and 5, and examined August 14), and after 11 to 14 days (1 beetle, fed August 2, 4, and 5, and examined August 16). A larva, less developed than those observed in the beetles fed 8 days previously, was found in a naturally infested beetle which also contained larvae of more advanced development, some of which exhibited completely formed cysticercoids.

Larvae were examined as fresh material and also as both stained and unstained permanent mounts. Two beetles were sectioned for observation of larvae *in situ*.

DEVELOPMENT OF LARVA IN INTERMEDIATE HOST

The youngest larvae of *H. cantaniana* observed were obtained from a beetle 24 hours after experimental infection; the identification of the larvae was based on the embryonal hooks which were 13 to 14μ long. One larva, observed soon after it was recovered from the body of a beetle, was slightly elongate and became rounded during observation; as unfixed material it was undifferentiated in appearance and disintegrated quickly. A similar elongate specimen measured 106μ long by 54μ wide. A third larva (Fig. 2) was trilobed, being about 160μ along its greatest axis; another larva (Fig. 3), more definitely lobed, measured about 200μ along its greatest axis. At least 6 small lobes or branches were exhibited by a smaller larva (Fig. 4) of unknown age which measured about 140μ along its greatest axis after having been mounted and stained with methylene blue. It is considered typical of early branching or proliferating larvae of this species; its nuclei are comparatively large and are definitely more concentrated near the tip of each branch. Apparently the first few branches elongate (Fig. 5)



Figs. 2–6.—Larvae of *Hymenolepis cantaniana* from *Ataenius cognatus* Figs. 2–3.—Obtained 24 hours after experimental feeding. Fig. 4.—Young larva, natural infestation. Fig. 5.—Sketch of branching larva, 8 days after experimental feeding Fig 6.—Completely formed cysticercoid Sectioned material.

before many new buds arise. A larva recovered from a beetle fed 8 days previously had a maximum axis length of 605μ and exhibited considerable proliferation, there being 4 distinct elongate branches and 2 rounded buds. Larvae from a beetle fed 9 to 12 days previously con-

sisted of numerous branches and a few buds which represent partly developed cysticercoids. Larvae recovered from a beetle of the same lot fed 11 to 14 days previously consisted of numerous branches, buds, partly formed and completely formed cysticercoids, the latter representing the infective larvae proper.

To summarize briefly on the basis of observations on numerous larvae, the hexacanth embryo develops into lobes, then a branching, mycelium-like structure, the branches of which bear buds which may develop into new elongate branches or directly into cysticercoids. In general, on the branching larval stem, the development of a bud into a cysticercoid resembles the more commonly observed development of hexacanth embryo into cysticercoid of other species of tapeworms, except that the embryonal hooks of *H. cantaniana* remain in the basal stem, or are lost, and consequently are not involved in the development of bud into cysticercoid (Figs. 1, 7, 8). A larva early in its development, still somewhat globular except for the area of attachment to the stem, is about 35 to 50μ in diameter; the cell nuclei are closer together than are those of the proliferating stem itself. These globular structures, while remaining attached to the stem, elongate and become ovoid; with further elongation constrictions appear; the first constriction results in a larva made up of a smaller proximal region, nearer the stem, and a larger distal region (Fig. 1c). Such larvae, with one constriction, may be 70 to 85μ long by 35μ in diameter through the proximal region and about 40 to 45μ in diameter through the distal region. Cells of the distal region are the more concentrated; in the median and proximal regions the outer cells lie close together, but the inner cells have elongate projections and form a loose tissue which represents the "primitive cavity" of the developing cysticercoid. While the first constriction, mentioned above, is becoming more marked, there occurs cell differentiation in the distal region in 4 areas which represent the future suckers. At the distal tip, a few large cells are to be observed which later develop as a projection representing the future rostellum; at an early stage this projection is 10.5μ long by 7μ in diameter.

A second constriction appears proximal to the suckers, and differentiation progresses. The region of loose fibrous tissue becomes more marked, suckers become more distinct, and a narrow cavity appears in the projecting rostellum, the latter 22μ long by 8μ in diameter. An individual specimen at this stage of development is 112μ long, 102μ in diameter through the suckers, 42.5μ through the median region, and 52.5μ through the posterior region.

A cysticercoid apparently just beginning to invaginate is 120μ long. Suckers appear to be completely formed, or nearly so, but the rostellum is not completely developed. *H. cantaniana* evidently belongs to the group of cestodes in which scolex differentiation of the larva is partially but not entirely completed before invagination. Invagination itself occurs rapidly, to judge from the comparatively few larvae observed in the process.

The region of attachment to the main stem elongates as the bud develops into a cysticercoid; it is fragile and breaks or disintegrates easily during observation of fresh material.

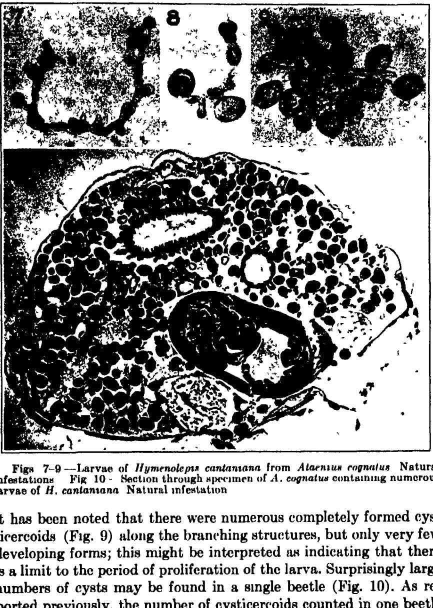
Calcareous corpuscles are first observed in young rounded forms; larvae with one constriction may contain 4 to 10 calcareous corpuscles which, as a rule, are median or distal in position. In completely formed cysticercoids as many as 40 have been counted; these are located in the inner cyst wall and thus are in the neck region of evaginated specimens.

Completely formed cysticercoids or infective larvae (Fig. 6) are spherical or ellipsoidal in shape or, in heavy infestations, may be irregularly compressed. They are comparatively small, 90μ by 68μ to 140μ by 102μ in diameter. The cyst wall consists of a thin cuticula, an inconspicuous basal membrane and sub-cuticular layer, a fibrous zone with irregular spaces representing the old "primitive cavity," and the inner cuticula. The scolex, lying in a small invagination cavity, is about 50 to 72μ in diameter; suckers are 20 to 26μ in diameter, the rostellum is about 22 to 24μ long, only the small rosteller cavity being easily observed in most material. No hooks could be seen on the scolex, although wrinkles of the cuticular lining of the rostellar cavity suggested minute hooks in certain specimens.

Completely formed cysticercoids may remain attached to the proliferating larval tissue by short stems or may lie free in the body cavity of freshly dissected beetles. Although cysticercoids become detached readily during the examination of the material, they do not evaginate readily in tap water, even when stimulated by tapping or heating the slide. Cysticercoids of *H. cantaniana* differ in this respect from those of *H. carioca* or *Raillietina cesticillus*, which evaginate much more readily.

On the basis of the limited material derived from experimental infections of beetles, it is concluded that at room temperature during mid-summer, in Washington, D. C., 11 to 14 days, as a minimum, are required for the cysticercoid to become completely formed. The time necessary for development at lower temperatures is not yet known.

Larval proliferation and development of cysticercoids appear to continue for at least 4 weeks, since in one lot of beetles, collected in mid-October and held so that re-infection was not possible, both completely formed and developmental stages were observed until early in December when the last beetle was killed. However, in some beetles,



Figs 7–9.—Larvae of *Hymenolepis cantaniana* from *Ataenius cognatus* Natural infestations Fig 10 - Section through specimen of *A. cognatus* containing numerous larvae of *H. cantaniana* Natural infestation

it has been noted that there were numerous completely formed cysticercoids (Fig. 9) along the branching structures, but only very few developing forms; this might be interpreted as indicating that there is a limit to the period of proliferation of the larva. Surprisingly large numbers of cysts may be found in a single beetle (Fig. 10). As reported previously, the number of cysticercoids counted in one beetle

was 1163, and in another individual, 2217; developing cysticercoids were not included in either count.

SEASONAL OCCURRENCE AND DISTRIBUTION OF INTERMEDIATE HOSTS

The dung beetle, *Ataenius cognatus* Leconte, has been collected near Beltsville, Maryland, from April to November, inclusive. According to information supplied by Dr. E. A. Chapin, this species is very common and widely distributed in the United States and is known to occur as far south as Mexico. In the vicinity of Washington, D. C., it may be collected at any time during the year when weather conditions are favorable.

Ataenius stercorator Fab. is believed to occur from Texas to Brazil and more generally in the West Indies. It has also been reported from Madeira.

Choeridium histeroides Weber has been collected in poultry yards near Beltsville, Maryland, but less frequently than *Ataenius cognatus* or *Aphodius granarius*. It is considered as being moderately common in the vicinity of Washington, D. C., and it may be found at any time during the year if the weather is favorable.

Numerous specimens of *Aphodius granarius* and *Onthophagus* spp., which also were collected from poultry yards near Beltsville, have been found consistently negative for larvae of *H. cantaniana*. Of 10 specimens each of *Aphodius granarius* and of *Ataenius cognatus* which were collected at the same time, from the same poultry yard, the specimens of *Aphodius granarius* were negative while 8 of the specimens of *Ataenius cognatus* contained larvae of *H. cantaniana*. Efforts to infect specimens of *Aphodius granarius* with *H. cantaniana* in the laboratory have been unsuccessful. On the basis of our present information, *Hymenolepis cantaniana* appears to exhibit more specificity as to its intermediate host than do other poultry tapeworms which use beetles in that capacity.

DEVELOPMENT OF HYMENOLEPIS CANTANIANA IN DEFINITIVE HOSTS

Birds were fed larvae from the beetle, *Ataenius cognatus*, as listed in table 1. No cestodes other than *H. cantaniana* were found in any bird and control birds remained free of cestodes.

As noted in table 1, one chick (a), which was examined 11 days after experimental feeding with *H. cantaniana* larvae, contained immature specimens of *H. cantaniana* about 3.5 mm. long. Chick G7068 passed eggs of *H. cantaniana* 14 days after experimental feeding; chick No. 91 passed eggs in droppings, and chick G7047 contained mature speci-

TABLE 1 —DEVELOPMENT OF HYMENOLEPIS CANTANIANA

HOST	DESIGNATION OF HOST	DATE OF FEEDING	DATE OF AUTOPSY	POST-MORTEM FINDINGS
Chick	1	Oct 26, 1932	Nov 2, 1932	Negative
	J3	Oct 26, 1932	Nov 14, 1932	About 10 almost mature tapeworms
	a	Oct 28, 1932	Nov 8, 1932	About 12 immature tapeworms
	b	Nov 10, 1932	Dec 2, 1932	Negative
	91	Nov. 15, 1932	Dec 7, 1932	Tapeworms present (eggs in feces, Dec 1)
	G7047	Nov. 16, 1932 (ca. 500 cysts)	Dec 2, 1932	21 mature tapeworms
	G7068	Nov 16, 1932 (ca 230 cysts)	Dec 20, 1932	44 mature tapeworms (eggs in feces, Nov 30)
	365	June 19, 1933	Died July 3, 1933	? (Bird decomposed)
	305	July 8, 1933	Aug 17, 1933	Few mature tapeworms
	310	July 8, 1933	Aug 17, 1933	Few mature tapeworms
	316	July 8, 1933	Aug 17, 1933	About 10 tapeworms
	345	July 21, 1933	Oct 3, 1933	Tapeworms present
	324	Aug. 21, 1933	Sept 21, 1933	Tapeworms present
	406	Sept 20, 1933	Nov 14, 1933	Numerous tapeworms
	407	Sept 20, 1933	Jan 4, 1934	Negative
	445	Sept 20, 1933	Jan 4, 1934	Negative
	421	Sept 20, 1933	Mar 10, 1934	Few tapeworms
Bobwhite quail	219	Aug 27, 1934	Sept 28, 1934	About 113 tapeworms
Guinea fowl	294	Aug 27, 1934	Nov 20, 1934	About 15 tapeworms

mens of *H. cantaniana*, 16 days after experimental feedings. Chick J3, examined 19 days after experimental feeding, contained specimens with egg-filled segments, but with the eggs apparently still unripe; no eggs or gravid segments were found in the posterior regions of the intestine. It is concluded that the time necessary for development of *H. cantaniana* in its definitive host probably varies from 2 to 3 weeks.

In all, 12 chickens, 1 guinea fowl and 1 bobwhite quail have become infested with *H. cantaniana* after being fed beetles containing proliferating cestode larvae. Four chicks remained negative after being fed and a fifth chick (365), which died, was so decomposed when examined that although no worms were found the negative results are somewhat inconclusive since, had specimens been present, they might well have been disintegrated by the time the bird was examined. It is interesting to note that one bird (421) remained infested from September 20, 1933, to March 10, 1934, a period of about 5½ months. Three birds were fed eggs of *H. cantaniana* in an attempt to demonstrate a direct life cycle, but all three birds remained negative for tapeworms.

MORPHOLOGY OF ADULT

Hymenolepis cantaniana (Polonio, 1860) Ransom, 1909. *Hymenolepis*: Worms up to 2.2 cm. long by 400μ wide. Scolex 120 to 160μ in diameter; suckers unarmed, 60 to 70μ in diameter; rostellum unarmed, 80 to 85μ long by 35μ wide, sac-like, the narrow cavity lined with cuticula sometimes wrinkled and striated in appearance Genital pores unilateral, anterior to middle of segment margin Testes 3, 1 aporal, 2 poral, usually arranged in a transverse row, but 1 aporal testis may be anterior and median, or dorsal and median, to other aporal testis, testes obscured rapidly by developing ovary and uterus, and at no time conspicuous in strobila External seminal vesicle near median line; internal seminal vesicle nearly filling cirrus pouch. Cirrus pouch thin-walled, elongate, 70 to 95μ long, extending nearly to middle of mature, but not of gravid, segments Vagina ventral to cirrus pouch, expanding into comparatively large oval seminal receptacle, for a time the most prominent structure in the segment. Ovary, when mature, sometimes extending to lateral excretory vessels and to anterior border of segment. Uterus sac-like, eventually filling nearly the whole segment and containing about 10 to 20 eggs. Eggs spherical, 45 to 60μ in diameter, oncosphere 22 to 25μ in diameter; embryonal hooks 13 to 14μ long.

Individual gravid segments or groups of 2 or 3 segments are found occasionally in droppings; however, as a rule, segments disintegrate early and individual eggs are found in the posterior portion of the intestine and in droppings Embryonal activity has been observed in eggs still present in gravid segments of freshly collected strobilae, in eggs from fresh droppings, and also in eggs kept as long as 6 days in a refrigerator (45° to 50°F.) Embryos are not easily activated on a slide as are those in gravid segments of *Davainea proglottina* and *Raillietina cesticillus*

Hosts.—Definitive: Galliformes (*Gallus gallus*, *Meleagris gallopavo*, *Pavo cristatus*, *Phasianus colchicus*, *Colinus virginianus* and *Numida meleagris*).

Intermediate: Coleoptera (*Ataenius cognatus*, *A stercorator*, and *Choeridium histeroides*)

Location. —Small intestine, usually duodenum of definitive host; body cavity, connective tissue and, less commonly, muscular tissue of intermediate host

Geographical distribution - -Europe (France, Spain, Italy, Jugo-Slavia and U. S. S. R.), Asia (Japan and Indo-China), South America (Brazil), and North America (United States, including Puerto Rico).

SUMMARY

Early developmental stages of proliferating larvae were obtained from 5 specimens of the beetle, *Ataenius cognatus*, which were dissected at varying periods after having been fed eggs of *Hymenolepis cantaniana*.

The hexacanth embryo was found to develop into a larva of several lobes, the latter elongating to form a somewhat branched, mycelium-like, structure; buds arose along the branches which developed into new branches or directly into cysticercoids containing the unarmed scolex characteristic of the species. Development of the bud into the cysticercoid resembles in general the development of other *Hymenolepis* larvae; the process consists of elongation, slight cavity formation, constriction, differentiation of scolex in most details and in-

vagination of cephalic region, resulting in a rounded cysticercoid. Scolex differentiation of *H. cantaniana* is partially, but not entirely, completed before invagination.

On the basis of the experimental findings, the minimum time required for development of an infective larva in the beetle host is from 11 to 14 days; proliferation of the larva and development of new cysticercoids apparently may continue for at least 4 weeks.

Development of the adult worm in the chicken requires at least 14 days and the time probably varies from 2 to 3 weeks.

Twelve chickens, 1 quail and 1 guinea fowl became infested with *Hymenolepis cantaniana* as a result of feeding branched cestode larvae obtained from naturally infested specimens of the beetle, *Ataenius cognatus*.

The beetles *Choeridium histeroides* and *Ataenius stercorator* are reported as additional intermediate hosts, on the basis of their harboring larvae similar to those found in *Ataenius cognatus* and known to be larvae of *H. cantaniana*.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETY

BOTANICAL SOCIETY

SPECIAL MEETING

A special meeting was held in the auditorium of the Interior Department Building on December 11, President W. W. DIEHL presiding; attendance 80.

Program: F. A. MCCLURE: *A garden of oriental bamboos* (illustrated with lantern).

H. H. BARTLETT, University of Michigan. Professor Bartlett discussed the activities and recommendations of the subcommittee on the reorganization of the National Botanic Garden. He emphasized the fact that the present appropriation for the botanic garden was sufficient to maintain a garden of high professional standards, especially in view of the availability of co-operating agencies in Washington Under the proposed plan the garden would be administered by a botanist of recognized standing, as Director, under the auspices of the Joint Congressional Committee on the Library An advisory board of directors with representatives from the Smithsonian Institution, the Department of Agriculture, and various scientific societies would also be appointed.

Following Professor Bartlett's remarks, discussion of the proposed plan ensued, and the Society took formal action approving the reorganization of the National Botanic Garden along the general lines outlined in Professor Bartlett's report. The secretary was directed to notify the Chairman of the Joint Congressional Committee on the Library of the Society's action.

262ND MEETING

The 262nd regular meeting was held in the Assembly Hall of the Cosmos Club, January 8, 1935, President DIEHL presiding; attendance 95. J. E. MCMURTREY was elected to membership.

Notes and reviews: Brief reports on the Pittsburgh meeting of the American Association for the Advancement of Science were presented as follows: Mycology, J. A. STEVENSON; Phytopathology, H. P. BARSS; General Botany, A. S. HITCHCOCK; Plant Physiology, C. F. SWINGLE; Horticulture, G. M. DARROW; Publicity, FRANK THONE. A report of the Chicago meeting of the American Society of Bacteriologists was presented by N. R. SMITH.

Program. J. R. CHRISTIE: *The development of nematode root galls* (illustrated with lantern).—Abstract published in Phytopathology, December 1934. To be published in full in Phytopathology.

J. R. SWALLEN: *The arid regions of northeastern Brazil* (illustrated with lantern).

263RD MEETING

The 253rd regular meeting was held in the Assembly Hall of the Cosmos Club, February 5, 1935, President DIEHL presiding; attendance 80. HARRY A. ALLARD and HENRY E ALLANSON were elected to membership. Article IX of the by-laws was amended authorizing the executive committee to reinstate absentee, resigned, and expelled members.

Notes and reviews: C. L. SHEAR reviewed *Monographia Discomycetum Bohemiae*, by JOS. VELENOVSKY (Praha 1934, 2 parts, text and plates) This work includes 1471 species, of which 800 are new, with 40 new genera.

R. K. BEATTIE reviewed the forthcoming book on systematic botany being published in English and Siamese, by HILDA S CUNNIFF

Program: F. C MEIER. *Spore collections in the atmosphere over the North Atlantic and Greenland made during the Lindbergh flight of 1932* (with lantern) —Published in full in Scientific Monthly, January 1935.

C. E COTTAM: *Present status of the eelgrass disease along the Atlantic Coast of North America* —Published in full as Wildlife Research & Management Leaflet BS-3, February 1935.

C. O. ERLANSON: *An adaptation of the moss, Tetraplodon for the dispersal of its spores by carrion flies.*

264TH MEETING

The 264th regular meeting was held in the Assembly Hall of the Cosmos Club, March 5, 1935, President DIEHL presiding; attendance 100. The following were elected to membership: E. G. BEINHART, H. W. BARRE, C. O. ERLANSON, RALPH M. LINDGREN, F. SIDNEY BEECHER, SABURO KATSURA, W. C. LOWDERMILK, F. L. MULFORD, HILDA S CUNNIFF, MARGUERITE WILCOX, GUY E. YERKES.

Notes and reviews. J. B. S. NORTON reviewed the new edition of Webster's dictionary from the standpoint of its usefulness in strictly botanical work. M C. MERRILL reviewed the latest number (Vol. 8) of the Transactions of the Bose Research Institute, Calcutta.

Program: ROBERT F. GRIGGS: *Dionaea's place in Nature* (with lantern)

A. S. HITCHCOCK: *The Grasses of the United States* (with lantern) —There are in the United States 159 genera and 1100 species of grasses By means of slides about 40 species of grasses were shown, chosen to illustrate the advance in structure from the simple to the complex. The Bambuseae are regarded as the most primitive and the Andropogoneae the most complex, with Indian corn (*Zea mays*) the culmination of the series.—*Author's abstract.*

265TH MEETING

The 265th meeting consisted of the annual banquet and dance, held in the ball room of the Kennedy-Warren, April 2, 1935; attendance 187.

Program: WM. H WESTON JR.: *Sex in the lower fungi.*

CHARLES F. SWINGLE, *Recording Secretary*

SCIENTIFIC NOTES AND NEWS

Prepared by Science Service

NOTES

Geological Survey.—L. M. PRINDLE has been engaged on an examination of the Enoree Purchase Unit for the Forest Service and is now undertaking a study of the saprolites or deeply rotted crystalline rocks of the gold belt in the Southern Appalachians, especially in Georgia It is thought that a study of the heavy minerals in the saprolite will help direct the search for the most favorable gold-bearing localities. He has turned in for transmittal to the Forest Service reports on the Uharie Unit, N. C., as well as on the Enoree tract.

Soil Erosion.—All work aiming at the control of soil erosion has been consolidated in a new soil erosion unit established by order of Secretary of Agriculture HENRY A WALLACE Under-Secretary REXFORD G TUGWELL has undertaken the administrative task of organizing the new unit, which is under the immediate direction of H H. BENNETT The consolidation affected the Soil Erosion Service, formerly under the Department of the Interior, and various phases of soil erosion investigation hitherto carried on by the Bureau of Chemistry and Soils, the Bureau of Agricultural Engineering and the Bureau of Plant Industry. Research will be conducted at ten field stations, and the large-scale demonstrations already in progress will be continued and extended.

Aviation Weather—More detailed weather news for fliers, at slightly longer intervals, began on May 1 Observations, maps, and forecasts prepared by the U S Weather Bureau now go out every six hours, instead of every four hours as formerly, over the teletype circuit maintained by the Bureau of Air Commerce along the airways of the United States

Each main airport station receives, every six hours, enough information for the preparation of a weather map of the whole United States, as well as the details of conditions in a wide area around it

All pilot balloon observations have been advanced one hour, so that the six hour reports and the airplane observations may be received in time to be checked and analyzed for use in making the maps Lengthening the periods of teletype transmission makes it possible to send over circuits west of Kansas City and Chicago full weather reports from ships in the Pacific and also permits some increase in reports from Canada and Mexico

Department of Terrestrial Magnetism.—In order to expedite the transmission of scientific data between the Department of Terrestrial Magnetism of the Carnegie Institution of Washington and its magnetic observatory at Watheroo, Western Australia, the Australian Government has recently authorized the installation at the observatory of an equipment of sufficient power for direct communication with Washington, D. C. The installation has been completed and communication established with radio stations at Washington Grove, Maryland (just outside of Washington) and Fresno, California During periods when direct communications through Washington Grove is not possible, messages are relayed through the West-Coast station Thus it is possible for scientific information obtained at Watheroo to be transmitted to Washington without delay and schedules are maintained for this purpose

There have been received recently in Washington an extensive series of magnetic records, control-observations, absolute determinations at field stations in Antarctica during sledge trips, etc., successfully carried out by the Byrd Antarctic Expedition II, during the period February 1934 to February 1935.

New Non-Magnetic Ship.—A first instalment of 10,023 pounds, towards the construction by the British Admiralty of a non-magnetic vessel has been included in this year's Naval Estimates presented to the House of Commons on March 6. The purpose of this new vessel is to resume the ocean magnetic-survey work which was carried on by the CARNEGIE, under the auspices of the Carnegie Institution of Washington, before her destruction by explosion and fire on November 29, 1929, in harbor at Apia, Western Samoa.

The magnetic charts published by the British and other governments for use at sea have been based in recent years to an increasingly large extent upon data provided by the CARNEGIE. There are, however, serious gaps in the present data which would have been filled if the CARNEGIE had completed her last cruise. These gaps together with a recent rapid change in the secular variation in the Indian Ocean, render the extrapolated values of the magnetic elements in the southern Indian Ocean unreliable and indicate the possibility of serious errors in future charts of this and other ocean areas. Since the Carnegie Institution of Washington has decided not to replace the CARNEGIE, the British Government, in view of her large maritime interests, has assumed the responsibility. The details of the design of the new non-magnetic vessel, the primary purpose of which will be the determination of magnetic data at sea, have not yet been made public, though it is probable that the new vessel will be larger than the CARNEGIE.

National Park Service.—J. Thomas Schneider, at the special request of the Secretary of the Interior is working on legislation calling for the preservation of historic sites and buildings. Mr. Schneider recently made a survey of European historic sites.

Study of Maternal Care.—The Children's Bureau has completed what is expected to be the first of a series of studies of community provisions for maternal care. This first study, in Hartford, Conn., was undertaken at the invitation of the Hartford Medical Society, which appointed an advisory committee of five members for the study, representing also the local hospitals.

Data was obtained as to all deliveries of women resident in the city of Hartford that occurred during two periods of three months each—May, June and July, 1933, and January, February, and March, 1934, a total of about 1,200. The necessary information was obtained by means of interviews with the attending physician, by study of the hospital records, by reports from the visiting-nurse association, and by interviews with the mothers themselves three months or more after the delivery. These interviews were always obtained with the consent of the physicians attending the women.

The purpose of this series of studies is to ascertain: the type of maternal care received by an unselected series of mothers in different localities; and the proportion of these mothers having abnormalities or morbidity.

The results of the present study are now being analyzed in preparation for the writing of the report.

Paleontological Society.—The Paleontological Society of Washington was organized Wednesday evening, December 19, 1934, in the U. S. National Museum. The purpose of the Society is to promote a closer understanding between the fields of biology and paleontology; to offer opportunity for open, informal discussion of biological and paleontological theory; and to provide a suitable place for the presentation of original and technical papers of general interest to research workers in both of the fields of science.

The following officers were elected: Honorary President, DAVID WHITE (since deceased); President, CHARLES W GILMORE; Vice-President, REMINGTON KELLOGG; Secretary, LLOYD G. HENBEST; Treasurer, G ARTHUR COOPER; Member of the Council, S. F. BLAKE. Meetings are held the third Wednesday evening of each month The programs at present are planned to include brief communications, reviews, etc , regular papers; and to provide at least one-half of the time for informal discussion on a previously announced subject.

International Zoological Congress.—The Twelfth International Zoological Congress will be held in Lisbon, Portugal, under the patronage of the President of the Portuguese Republic from Sunday, September 15th to Saturday, September 21st, 1935 Sessions of the Congress will be held at the University of Lisbon under the presidency of Dr A RICARDO JORGE, Professor of the Faculty of Sciences of the University and Director of the Zoological and Anthropological Department of the National Museum of Natural History.

Field Conference of Pennsylvania Geologists.—The fifth annual meeting of the Field Conference of Pennsylvania Geologists will have its headquarters at the Academy of Natural Sciences in Philadelphia on Friday, May 31st Sunday, June 2nd Registration and museum tours will take place from 9 A M. to 12 M on Friday, May 31st, and at 2 P M. the first of the trips will leave Philadelphia to observe the physiography of the Piedmont upland and the adjacent Coastal Plain terraces around Philadelphia An alternative trip to localities of mineralogic and petrologic interest to the north of Philadelphia will also be conducted on that afternoon. On Saturday, June 1st, the Conference will leave the Academy at 8 A.M. on a general trip through the crystalline and intrusive rocks of the Piedmont Belt in the Philadelphia area. On Sunday, June 2nd, they will leave at the same time to examine the lower Paleozoic formations and their relations to the pre-Cambrian rocks in the area west of Philadelphia. This trip will go as far west as Quarryville which is the type area of the Martic overthrust. On Monday, June 3rd, a post-Conference optional excursion to the Coastal Plain of New Jersey will be conducted.

NEWS BRIEFS

A Pan-American pact for the protection of art galleries and scientific museums during war was signed at the White House on April 15 by representatives of Bolivia, Brazil, Chile, the Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, the United States and Uruguay. By the terms of the pact, certain cultural buildings, sites and monuments, marked with a banner of peace, are to be considered neutral zones in time of war, and as such shall be immune from airplane bombing and other acts of hostility.

The National Zoological Park has received an allotment of $680,000 from PWA funds. It is planned to build an addition to the bird house, a new elephant house and a house for small mammals, with special accomodations for apes. It is also planned to provide a machine shop.

Two unusual meteorites, both seen to strike the earth in North Carolina, have just been received by the Smithsonian Institution, which will cooperate with the North Carolina State Museum in their analysis.

PERSONAL ITEMS

Dr. NOLAN D. C. LEWIS, director of laboratories at St. Elizabeth's Hospital, has been given leave of absence for the purpose of making a survey of existing research projects and methods of treatment and control of dementia praecox, as a preliminary step in a campaign against this disease financed by the Scottish Rite Masons of the northern jurisdiction of the United States.

The Remington Honor Medal, highest award in pharmacy, has been given for 1935 to SAMUEL LOUIS HILTON, retail pharmacist of this city, in recognition for his many years of service to his profession, and in particular for his efforts in connection with the building of the American Institute of Pharmacy, recently completed.

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BIOLOGY.—*Biology and human trends.*[1] RAYMOND PEARL, The Johns Hopkins University.

I

To discuss adequately in a brief address the assigned subject "biology and the social consequences of its advances" is plainly a large order, and one beset with considerable difficulties. For on the one hand biology as a science is still largely in the descriptive and historical phase of its development, and sociology is even more so, with the consequence that an account of the significant achievements of these sciences cannot be expressed in the concise and rational short hand that is so useful in physics; and, on the other hand, to appraise the theoretical consequences of scientific discoveries implies a certain skill in the dangerous art of prophecy. Not having any noteworthy aptitude as a prophet I can only put before you, in all modesty, the views of one biologist about some of the more evident relations between certain well-established biological facts and principles and some of the more characteristic features of the collective behavior of mankind. While I cannot speak with officially sanctioned authority for more than one particular biologist it does seem absolutely certain that just in proportion as any of the sciences, including biology, succeed in their effort to establish sound general principles and laws, just in that proportion will their advances be inevitably reflected in collective human behavior. The thoughts and actions of all mankind were permanently and irreversibly altered from what they were before, after the *Origin of Species* had been published in 1859. A corresponding alteration, more or less significant as the case may be, occurs whenever a *real* discovery in science is made, or a sound generalization established.

II

In the great Symphony of Life there appear to be three, and only three, main, basic biological themes, out of which come all the pleasant or harsh, useful or harmful, simple or complex counter-melodies,

[1] Received March 22, 1935.

harmonies, and dissonances of the business of living. These main basic themes are:

First: The urge to individual personal *survival* here and now. This appears to be an attribute of *all living* matter.

Second: The urge to *reproduction* which again appears to be a property of all that lives.

Third: *Variability*, once more common to all living matter, in both its genetic and somatic aspects, the one leading to the observed differences or variations between individual organisms, the other embodying the differences in the same individual at different times in its life.

Finally, it is to be remembered that it is impossible to discuss or even to imagine life or living things without taking into account the rest of the universe in which they exist. So then we must add to our material for discussion one more item that corresponds roughly to the fiddles, flutes, horns, printed music, desks, and other *impedimenta* not musical *per se* but without which a symphony would never reach the ears. This item is:

Fourth: The *environment* that conditions and in some degree determines all vital phenomena.

Let us now examine each of these four items in some detail.

The urge to survival[2] may fairly be regarded as the most fundamental attribute of living things and is therefore placed first in the list. It may be well to point out at the start that in its essence this urge to survival is rather completely and uncompromisingly selfish. To the best of its ability the individual organism so conducts its affairs as to continue living just as long as possible, regardless of what other organisms may do or think about it. When extinction threatens, every resource is brought to bear to fend it off. Basically this is what underlies the struggle for existence. Out of it, associated with it, and because of it come great ranges of biological phenomena that we have, for combined reasons of convenience and pedantry, departmentalized: such as food getting, metabolism and nutrition, cellular and humoral defense mechanisms furnishing immunity and resistance to disease, protective shelter seeking and building, natural selection, and in good part evolution itself.

[2] There are curious aspects to this universal urge to individual survival. One of them is the biological uselessness of much of it. It would be extremely difficult, if not impossible, to find any rational biological purpose served by the survival of the individual after it has reproduced itself. Yet in not a few organisms, including man, there is normally a considerable part of the life span lived after adequate reproduction has been accomplished. Living grandparents, great grandparents and celibate clergymen are among Nature's gaudier examples of Thorstein Veblen's "conspicuous waste" in the realm of pure biology.

As a matter of observed fact this survival urge is primal and deeply rooted. Whenever and wherever we see its fundamental selfishness apparently in abeyance or even much abated, and seemingly replaced by altruism or "mutual aid" as it has been called, we may be sure, I think, that one or the other of two things has happened. Either, as among the invertebrates (especially the social insects) and the lower vertebrates, the "mutual aid" is not individually motivated but is a mechanistic group consequence of caste differentiation and integration, with no more (and no less) of an altruistic element in it than there is in the cellular differentiation and integration in the embryonic development of the individual; or, as in man and to some extent among his nearest relatives, complex psychological elements have been added to the picture in the course of evolution, which may seem at times to overwhelm and obliterate the more primitive and deeply rooted biological urge. The most obvious of these added factors amounts really to a more enlightened self interest—that is to say a belief that for the present and until times get much worse it will be likely to conduce more effectively to individual survival to play along with and help one's neighbors in the crowd.

This statement is, from the necessity of brevity, much too bald and apparently dogmatic in its form, and wants more explanatory elucidation and development than we shall have time to give it. But I think it essentially conforms to at least a part of the reality. It is reasonable to suppose that the individual soldier ant is unaware of the fact that its activities and efforts are of benefit to the social group (the colony) to which it belongs. On the contrary it seems likely that when it fights it does so because it is its inherent and entailed nature so to do. In fighting it is expressing its own will-to-live or urge to survival, and in the only way of which it is capable. On the human side, in thinking of the personal motivation of altruistic behavior I am always reminded of a speech of Brotteaux in *Les Dieux ont Soif*, perhaps the greatest novel Antole France ever wrote. It is (I quote from Allinson's translation): "What I am doing now, the merit of which you exaggerate,—is not done for any love of you, for indeed, albeit you are a lovable man, . . . , I know you too little to love you. Nor yet do I act so for love of humanity; for I am not so simple as to think . . . that humanity has rights. . . . I do it out of that selfishness which inspires mankind to perform all their deeds of generosity and self-sacrifice, by making them recognize themselves in all who are unfortunate, by disposing them to commiserate their own calamities in the calamities of others and by inciting them to offer help to a mortal resembling them-

selves in nature and destiny, so that they think they are succouring themselves in succouring him."

Man's behavior, and particularly his social behavior, is motivated by so complex a set of physiological and psychological factors, appetites, emotions, and reasons, as to be extremely difficult to disentangle in a particular instance. But it may safely be said that whenever he curbs his primal urge to personal survival, he does it for secondary reasons superimposed upon his natural, protoplasmic will-to-live. Many of these reasons are, collectively, what we call social. They represent purposeful adaptations in what Wheeler has convincingly argued is the next emergent level above the individual organismal. In most human beings these secondary social adaptations of behavior are still somewhat incomplete and imperfect, as clearly appears in times of great stress or danger. And the extent to which the highest forms of human altruistic social adaptations have real and enduring survival value, has yet to be measured. It can be argued with some plausibility that why they give the appearance of having some survival value, or at least of not being positively harmful, is because they became even moderately widespread only during that recent portion of human history in which living has been relatively easy for all mankind. It has been relatively easy for two reasons· Low density of population, in general; and rapidly increasing knowledge of applied science with its accompanying industrial developments. In a world where getting a living was easy, altruistic social relations were correspondingly easy. Instances and localities of a real struggle for existence between individual men (other than during large caliber wars or in the processes incident to the assumption of the "white man's burden") have been rare in this world since the beginning of the nineteenth century. And few have ever seriously alleged that war is an altruistic enterprise; nor is it at all uncertain that the pleasures of "civilizing" backward peoples are, like those of condescension, singularly one-sided.

The urge to reproduce is second in power, if at all, only to that for survival. This basic attribute of living material, like the other, includes in its scope great ranges of academically labeled and pigeonholed biological phenomena—of which among the more important are perhaps population growth with its part in the struggle for existence and natural selection; and heredity with its concomitants of development and growth. For heredity is most clearly to be apprehended as an aspect of reproduction. Living things do not merely reproduce; they reproduce *themselves*. This fact makes it clear that,

philosophically viewed, the urge to reproduction is really a part—an extension if you like—of the primal urge to survival. If the individual cannot ensure his own indefinite earthly immortality he can and does try *his* very best to see that his stirp shall keep on living forever and ever. Naturally this self-reproductive process tends towards social as well as biological stability.

Genes are almost incredibly stable and resistant to alteration in the natural and usual circumstances of life. For something over fifteen years there has been going on in my laboratory a continuous experiment designed to test this point in a simple and direct way. Tonight I make the first public statement about it. This experiment has now included over 300 successive generations—perhaps the longest bit of controlled breeding ever carried out, with the results in each successive generation carefully observed and precisely recorded. Allowing 30 years as a round figure for the average duration of a human generation the time equivalent in human reproduction of this experiment would be of the order of 9000 years—considerably longer than the total span of man's even dimly recorded history. The objective of this experiment with *Drosophila* has been to see whether a simple Mendelian ratio involving but one character would or could be altered in the passage of time by such natural forces as selection, different systems of breeding (such, for example, as that called "grading up" by livestock breeders), and wide alterations of the environment nearly up to the limits of the organism's ability to go on living at all. The plan of the experiment is a simple one. It started by crossing a normal fruit fly (*Drosophila melanogaster*) possessing the normal wings characteristic of the species, with the pure mutant form *Vestigial*, so-called because the wings are reduced to non-functional vestiges. This wing characteristic is associated with a single gene. In the next generation all the flies produced by the pair with which we started had normal standard wings, normal being dominant to vestigial. These flies of the first cross-bred generation were then mated to pure vestigials (back-crossed to the recessive parent, in technical genetic language) to produce the second cross-bred generation. Of the offspring of these matings approximately one-half had normal wings, because they carried the original normal wing gene, and the other half had vestigial wings, all this being in accord with regular Mendelian expectation. The vestigial winged flies of this and all later generations were killed and thrown away as soon as they had emerged and been counted. The normal winged flies were again mated to pure vestigials to produce the next generation. And so on with undeviating regularity for

more than 300 generations. What the plan means in briefest terms is that since the rather stupendously long time (measured in generations) when the experiment began the only hereditary determiner (gene) for normal wings that has ever been in the system is the one that was contributed by the one single normal wild type fly with which we started. All the normal winged flies now appearing in the populations of the successive generations of the experiment have normal wings only because their *Urgrossvater* had them 300 generations ago, and for no other reason.

The net result of the experiment has been to show that the gene involved has preserved its initial characteristics unaltered. So also has the cellular mechanism for the shuffling and sorting of the genes in each generation. The approximately 50-50 ratio of normal winged to vestigial winged flies appears generation after generation with somewhat wearisome regularity. The demonstration of the inherent stability of the genic mechanism of heredity that this experiment has given is extremely impressive.

Analogous phenomena of organic stability are observed in nature. There are considerable numbers of firmly established instances of organisms living today that are *specifically* identical with their progenitors in earlier geological eras. Among the Foraminifera one species (*Lagena sulcata*) has persisted unchanged from Silurian times down to the present; one species (*Globigerina bulloides*) from the Devonian to the present; two species from the Carboniferous; two from the Permian; four from the Triassic; seven from the Jurassic; and fifteen from the Cretaceous. The significance of these cases cannot be overemphasized. When it is comprehended that organisms now living have not changed by a perceptible amount from what they were millions upon millions of years ago in paleozoic times in those *minutiae* of structure upon which systematists base their specific distinctions and descriptions, the conservatism and stability of nature begins to be realized.

In human biology the conservative and stable element of true biological heredity is supplemented and reinforced by what has been variously called "social heredity," or tradition, or the mores of the group to which the individual and his stirp belong. This is, of course, not inheritance at all in a proper biological sense. It is rather an environmental matter at bottom. A born Englishman transported to America as a child may, and in fact usually does, come as a man to think and act like an American. But to make him do this if he lives his whole life in England among the people of his kind would be vir-

tually impossible. And it is a matter of statistical fact that vastly more human beings live out their lives not far from where they were born and among their kind of people, than migrate or are transplanted into realms of other traditions and mores. In consequence "social inheritance" or tradition plays an enormous, but usually underestimated part in determining the individual and collective behavior of human beings. Its effects have not infrequently been confused with those of true biological heredity. Masses of data have been collected to show that near relatives, particularly fathers and sons, frequently follow the same professions or callings. It is often quite erroneously concluded that such facts prove a biological inheritance of talent or ability, either in general, or for a particular calling, or both. Such data are inherently incapable of proving any such a conclusion. The observations can be much more simply and satisfactorily accounted for in the main by the operation of the purely environmental factors of familiar contact from childhood, training, easy opportunity of entrance, and the social pressure of tradition; in short by "social" not biological inheritance.

Our third unique and universal biological principle, variability, has two aspects, as has already been pointed out. No two living organisms are exactly like each other in all particulars, and no single organism is precisely the same at any two moments in its lifetime. The first of these aspects is the only one that is conventionally called variability. It is mainly caused by the combined interaction of genetic shufflings and recombinations and the environment. The second aspect of organic variability is usually and conveniently called adaptability. It is an odd and remarkable phenomenon. The unique thing is not that organisms are more or less fitted or adapted to the circumstances in which they find themselves. Inanimate objects of various sorts, and particularly that category of them that we call machines are this. It is true that the adaptations of organisms and machines are brought about in different ways. But the fact of adaptation is present, and in principle identical, in both. We are, however, not concerned here with adaptation, but with self-started and self-controlled *adaptability*, which organisms have and machines do not. Organisms incessantly change and alter themselves to meet the fleeting changes in their circumstances. No living organism ever stays put. When it does it is dead, and in dying has passed into a wholly different category of matter.

The process goes even deeper than change and adaptability in behavior. The very material substance itself that makes up the living

organism is constantly changing. What then does "personal identity" connote? What we are pleased to call the same identical man at the age of 70 years is composed of extremely little if any of the same material substance that made him up when he was 20 years old. Probably there is not a single molecule in him at 70 that was there at 20. In the intervening years the only thing about him that has survived is his *pattern*, a sort of transcendental or spiritual wraith through which has flowed a steady stream of matter and energy. There is a profound truth embodied in Cuvier's old comparison of a living organism to a whirlpool. It is the pattern that is the essence of the business. It alone endures. And it is constantly altering and adapting itself to changing circumstances. Especially is this true and important of the psychological panel of the total pattern of the human organism. It is this aspect of adaptability, the capacity of organisms for change ending only with death, that seems to be more important in its social consequences than its teleological aspect, if indeed we are prepared to admit the reality of the latter at all, as some are not.

We may conclude this hasty survey of basic principles with a word or two about the environment. The *effective* environment of any particular living organism is determined by the pattern of that organism, just as truly as the pattern of the organism is in part at least determined by the environment. For a particular man, and for a group of similar men, but not for any mouse, the relative honesty of his banker and the urbanity of his dean are highly important elements in the effective environment. And what makes them so is not the bankishness of the banker nor the deanishness of the dean, but the pattern of the particular man of whom we are speaking—a pattern not shared by the mouse. In short the relation between organism and environment is everywhere and always mutually reciprocal and as man is the most complicated and manifoldly diverse in his capabilities of all organisms, so also is his effective environment the most complicated.

More extensively and more effectively than any other organism he *makes his own environment.* He is constantly altering it in the hope of making it better. But such is the interplay of the contradictory biological elements in his nature that he dislikes and resists any alteration of his environment by anyone else than himself or the group of people similar to himself to which he belongs. The social and political consequences of these opposing attitudes are far-reaching and encompass within their range the greater part of our communal troubles in this imperfect world.

The full implications of the reciprocally determinative influences of

organism and environment seem to me to have been generally somewhat less than adequately valued in the last century's development of biological thought, and certainly an extremely inadequate amount of first-rate research has been put upon the matter. This is partly an obvious consequence of the trend given to biological philosophy by Darwin, Galton, Weismann and Mendel, with their emphasis upon the entailed or endowed element in the whole biological picture. In human biology particularly the rôle played by heredity has come to take on many of the aspects of religious dogma. Indeed it has been urged that eugenics should be overtly espoused and developed as a religion. And all this has been going on in a world where consciously planned and directed alterations of environmental conditions have had far-reaching and profound biological effects upon whole populations, not alone in the field of public health but in many others. Every geneticist knows that the final expression in the individual of each hereditary determiner is conditioned by the environmental circumstances under which its development is undergone. Yet very little has been done in the way of attempting to analyze thoroughly and penetratingly the biological effects of environmental conditions upon human beings.

In truth science, perhaps in common with all other modes of human thought, has a seemingly ineradicable tendency to crystallize its temporarily successful philosophies into dogma, and having accomplished the crystallization proceeds to the scourging of whatever skeptics and heretics may appear. Public health workers sometimes display a religious attitude toward their achievements as intense as the crusading zeal of the eugenists for their dogmas. Only a few hardy souls throughout history and at the present time seem able to realize for longer than brief periods that new knowledge is more often than in any other way engendered out of skepticism by hard work, and that religious attitudes and modes of thought for however noble a purpose enlisted not only have nothing whatsoever to do with science, but are the most effective hindrances to getting new knowledge yet heard of.

III

Let us now turn to the examination of some of the more conspicuous and far-reaching social consequences of the basic biological principles we have briefly reviewed. The three most obvious and important ones are, I think, that:

1. Man is enjoying better health and individually surviving longer

than ever before, likes it, and intends to go farther along the same road.

2. He is vaguely conscious of being more crowded than ever before, and finds the various consequences of this crowding increasingly unpleasant, but chiefly because it threatens that enhanced survival that is always his first and deepest biological concern.

3. Therefore he is groping about to find ways to alleviate the progressive overcrowding and preserve the health and survival gains he has made; trying a great variety of experiments, some of which are sensible, others highly dubious, and a few completely idiotic.

For the sake of clarity these three statements need a little expansion. The urge to survival is the ultimate biological motivating factor that has transferred the maintenance and improvement of health from an individual to a social concern. The gains in this field have been enormous. How enormous perhaps only a statistician can appreciate. This is not the place, nor is there any need, to go into the question of how they have been achieved. But the interesting thing about the case, broadly viewed, is that without the abatement by a single bit of that basic individual selfishness in which the biological urge for survival is rooted, it has been perceived that this urge can be most effectively served so far as health is concerned by making a social matter of a great part of it. Assuring a pure water supply and innocuously disposing of the waste matters of living are things that the individual simply cannot do well. Society can. And the social progression of the urge to survival in the field of health is by no means at an end yet. In two directions we may confidently look forward to great further changes and advances in the rather immediate future. In the first place, whether we or the physicians like it or not, it seems clear that the maintenance and improvement of *individual* health is going to become more and more completely a social matter. The basic reasons are two-fold, partly because of the continued normal evolutionary further growth of the same ideas and considerations that have brought us to where we are now regarding public health; partly because of economic and political considerations. The number of persons who at the present time get inadequate medical care because they cannot individually afford to pay for adequate (and lacking it endanger other peoples' health) is so large that as a group they are already in a position politically to demand and get necessary medical service, and may reasonably be counted upon shortly to do so. In the second place it seems reasonable to suppose that advances in medical science are going to continue. The last seventy-five years —an exces-

sively small fraction of mankind's earthly history—have witnessed more progress in knowledge of disease and its effective treatment and prevention, than was made in all the time that went before. And objectively viewed the rate of advance in medical discovery seems plainly to be accelerating rather than slowing.

Turning now to the consideration of the social consequences of the urge to reproduce it is immediately to be noted that the growing consciousness of overcrowding—too many people in the world for comfort—is not the resultant of such simple matters as lack of space in which to build dwellings or to move about, or of inability to produce food enough to satisfy the collective hunger. It is true that the total number of living human beings on the globe at this moment is probably something closely approaching two billion. But the gross land area of the globe is about 35 billion acres, so that on an equal parcelling each individual man, woman and child would have over 17 acres. If the total population of the earth were to be forcibly put upon the smallest of the continents—Australia—there would still be, on an equal division, well over an acre for each individual. Similarly relative to food whatever trouble there is relates to distribution rather than production. Such famines as occur now happen not because there is not enough food produced to feed everyone, but because the complex economic mechanism of getting it to the hungry works imperfectly.

The social consequences of population growth present a much more subtle and complicated problem than mere space or food. The suggestion just made that the total land area of the globe might be equally divided per head of population is an obviously fantastic one, with only a sterile arithmetic meaning. Not all the land is equally useful for sustaining human life either directly or indirectly. Some of it is of no use whatever. And this brings us to the crux of the population problem, which is that each unit of the population must somehow or other *get its living*. All other forms of life except man get their living by one or the other or a combination of two direct ways. These are (1) by preying upon other living things, plant or animal; or (2) directly converting inorganic materials into living substance. Man today gets his living by indirect processes conveniently labelled economic. He is in the main employed in doing things that he can trade with somebody else for the biological requisites for living. The population of the world has now become so large, and the discoveries and applications of science have made the producing of the things that can be traded so much easier than it used to be, that great numbers of people all over the world find themselves unable to get a living by this process

that was formerly so relatively simple. The rapid development of the industrial type of civilization in the nineteenth century made the gloomy prophecies of Malthus at its beginning look silly. The population grew at a tremendous pace when he thought its growth would be checked by want and misery. And people were having, by and large, a grand time while their number was increasing; because they were experiencing the enormous improvements in the physical comforts of living that came with the advance and applications of science. But these very factors, plus the enhanced survival rate coincident with the development of public health, caused the ugly spectre of unemployment to rear itself higher and higher until it has now become the most serious problem that humanity faces.

It is to be noted at this point that in modern civilization, as a normal consequence of the relation of individual man's biology to his age, approximately 50 per cent of all human beings have to earn the livings not only of themselves but also the major part of that of the other 50 per cent. Man develops slowly. Children are incapable of earning their own livings before they are about 15 years old, and have passed approximately a sixth of their total life span, and between a third and a fourth of their average life duration. At the other end of life, for the great majority of human beings over 50 years of age their living must come in whole or in considerable part either from the efforts of the active workers between 15 and 50, or from what they themselves were able to save while they were in their productively efficient ages. In practically all countries the sum of the numbers of persons under 15 and of those over 50, is almost exactly equal to the number of those between 15 and 50 years of age. But over and above this burden, that may fairly be called a normal biological one, the world's workers are now called upon to support the unemployed. A considerable part of the unemployed are so because they are unemployable—not sufficiently fit and able in a biological sense to make an honest living in a world organized as this one is. These unfit organisms are kept alive by the rest of society for no realistically demonstrable reason other than that they were once born, and by being born somehow placed upon the rest of mankind what has gradually come to be regarded as a permanently binding obligation to see that they do not die. The remainder of the unemployed are so because there are too many fit, able and employable people in the world to do the necessary world's work, the aggregate amount of which has been, is being, and will continue to be steadily reduced by discoveries and improvements in the sciences and arts.

Mankind is trying in several ways to meet this situation. The first and in the long run perhaps the most important way is by reducing its reproductive rate through the practice of contraception—birth control. It has been seriously alleged and with at least some justification, that even the admittedly imperfect techniques of contraception as they are now known constitute the most important biological discovery ever made. While historians of the subject attempt to show that the practice of contraception is almost if not quite as ancient as man's recorded history, actually the birth rates of large population aggregates did not begin to be sensibly affected by it until roughly the last quarter of the nineteenth century; that is to say since the beginning of the rapid development of the highly organized, integrated and urbanized industrial type of civilization. At the present time the effects of contraception on the birth rate are plainly apparent over large and leading parts of the world's population, and are growing at a rather rapid rate.

The practice of birth control is a thoroughly sound, sensible, and in the long run effective method of meeting the problem consequent upon the biological urge to reproduction operating in a universe of definitely limited size. The only objection of importance that can be urged against it is that it has led to an unfavorable differential fertility. The socially and economically more fortunate classes of mankind have practised contraception more regularly, frequently, and effectively than the less fortunate social and economic classes, with consequently reduced reproductive rates. It is contended that this has brought about a steady deterioration and degeneration of man as a species, and will continue to do so until all progress is stopped. After prolonged study of the matter it is my opinion that the alleged detrimental consequences of this class differential fertility upon the aggregate biological and social fitness and worth of mankind, while doubtless present in some degree, have probably been greatly exaggerated in the reformer's zeal to make his case. This is not the place, nor is there time, to state and document all the reasons that have led me to this view. But there are certain considerations that must be mentioned because they have been so consistently overlooked or suppressed. The first is the tacit assumption that lies at the very root of the argument. This assumption is that generally speaking and with negligible exceptions the more fortunate social and economic classes are in that position because they are composed of not only mentally, morally, and physically, but also genetically superior people. But it may be alleged with at least equal truth that these very people who

are regarded as mentally, morally, and physically superior are that way in no small part only because they and their forebears have been fortunate socially and economically. The analogy often drawn between human breeding and live stock breeding is in part specious and misleading. In animal breeding it has been learned that the only reliable measure of genetic superiority is the progeny test—the test of quality of the offspring actually produced. Breeding in the light of this test may, and often does, lead to the rapid, sure, and permanent improvement of a strain of livestock. But when the results of *human* breeding are interpreted in the light of the clear principles of the progeny test the eugenic case does not fare so well. In absolute numbers the vast majority of the most superior people in the world's history have in fact been produced by mediocre or inferior forebears; and furthermore the admittedly most superior folk have in the main been singularly unfortunate in their progeny, again in absolute numbers. No one would question the desirability of the free multiplication of people who are really superior genetically. But in human society as it exists under present conditions of civilization many a gaudy and imposing phenotype masks a very mediocre or worse genotype, and *vice-versa*. And most eugenic selection of human beings is, and in the nature of the case must be, based solely upon phenotypic manifestations.

Naturally it is to be understood that what has been said does not refer to the problem of the really biologically defective and degenerate members of society. There the eugenic position is sound and admirable in principle. The breeding of such people must be stopped; and by compulsory measures. Voluntary birth control will not help appreciably to the solution of the problem, for the persons concerned are not of a sort to make effective use of contraception. If all the contraceptive techniques in the world were made fully available to them they would still go on breeding. There are but three ways, all somewhat imperfect, of dealing with them; they must be segregated, or sterilized, or denied any aid in the struggle for existence and thus allowed and encouraged to perish because too unfit biologically to make livings for themselves with their own unaided resources.

One final point and I shall have done with this phase of our subject. It is a curious fact that at every stage of man's history from at least the time of Plato, and indeed of Theognis of Megara a century before that, there have been those who have been just as certain as some present day eugenists are, and just as deeply grieved, that mankind was going rapidly to the dogs because the right kind of people

were not breeding enough and the wrong kind of people were breeding too much. Perhaps men are nearer the dogs now than they were in the Alexandrian age; but I venture to doubt it. The evidence seems to me overwhelming that mankind is, on an average, mentally, morally, and physically much superior today to what it was when Socrates was abated as a public nuisance.

So much for birth control and the eugenic objections to its alleged consequences. We turn now to the most ineffective, cruel, and altogether foolish large scale method by which society tries periodically to ameliorate the consequences of the biological urge to reproduction, namely war. If this characterization is reasonably in accord with reality why do we go on having wars? The reason has been stated with precision by a clear thinking human biologist, C. C. Walker, in the following words:

"The natural striving after security by one people, that is to say its natural endeavors to exist, must affect the security of other peoples. Because when a people endeavors to ensure its existence, by reason of its automatic reactions to the problems connected with food-supply, security, and social stability, its endeavors will conflict with the strivings of other peoples who are also subject to the same environmental problems. Each people is only trying to exist. When a people considers that its existence is threatened by a particular environment, . . . to such an extent that no adaptation to the environment will suffice, it is forced to attempt to alter that environment. But other people may consider that any alteration of that environment affects its own existence. The result is war."

Is there any reason to suppose that this biologically natural process, with its characteristic of almost rhythmic recurrence, will ever come to an end? It seems to me there can be such a hope only in the long —very, very long—run. And the only reason I can see for even this deferred hope is the already great and rapidly increasing ease, speed, and cheapness of transportation and communication between all parts of the world. The slow but steady and sure biological effect of easy getting about will inevitably be more and more interbreeding, with a gradual lessening of the racial and national differences between human beings. In the far-off end all mankind will presumably be a rather uniform lot; all looking, thinking, and acting pretty much the same way, like sheep. National or racial isolation has even now become extremely difficult to maintain; indeed in a quite literal sense the attempt to maintain such isolations already threatens group survival in not a few instances. In the long run they cannot and will

not be maintained. Just in proportion as they diminish so will the frequency of wars diminish. But the diminution seems likely to be at a fearfully slow rate; it will be a long time yet before the *last* war is fought. And a low cynic might suggest that even war, horrid and stupid as it is, would be preferable to that deadly uniformity among men towards which we are slowly but surely breeding our way.

Society here and abroad is just now experimenting with a whole series of internal readjustments that are being forcibly imposed upon temporarily dazed but always adaptable populations, in the hope that out of them will come a real and permanent solution of the problem that man's urge to reproduction has saddled upon us. All of these experiments appear to fall into a few simple categories when realistically examined. They all stem from and put into practice one or the other of two ideas, neither of which finds unqualified support in the science of biology. The first of these ideas is that it is best to let one individual in a group run the group's affairs; permanently, absolutely and without interference, on the philosophy that averaged opinion and averaged action are as stupid, inefficient and unreal as an averaged egg is innutritious and unreal. The other and opposite idea is that it is best to have the whole group run the business as a whole, allowing no individual any powers except as a merely mechanical executor of the group's will, on the philosophy that no individual is really superior to another and that therefore in averaged opinion and action wisdom alone resides. In their practical implementation, performance, and effects both ideas turn out to be singularly alike. Both alike scorn the intermediate idea of true democracy. And finally both attempt to solve the problem that is pestering the world by a simple procedure universally regarded as criminal when practiced by an individual. It is that the more abundant life is to be assured to a too abundant people by stealing goods from the prudent and efficient, and then giving them to the imprudent and inefficient. Since there are always a great many more of the latter kind of people than of the former this turns out temporarily to be the most effective political device ever heard of. Whether it will prove to be so permanently is less certain. It has been pointed out earlier in this paper that adaptable as man is there are nevertheless elements of conservative stability in his biological make-up whose roots go back to the very beginning of his evolution. And in that perfect state of society envisaged by our major prophets, where "economy of plenty" will assure, as we are told, that no one will have to work *much* for a living, and where the higher philosophy that holds "human rights above property rights"

(without perhaps clearly understanding what it means by either) assures that in any event everybody shall be kept alive at public expense whether he works or not, is there not the barest possibility that there might appear a somewhat general inclination on the part of the more intelligent members of the group to opt for the philosophy rather than for the communal work (however slight in amount)? If anything like this should happen might not the economy of plenty some day find itself once again in a parlous state of unplenty? Not being myself a dependable prophet I venture no answer. But in any case, and regardless of details, it is difficult to convince a biologist that a social philosophy will endure for any great length of time that deliberately and complacently loads upon the always weary backs of the able and fit an evergrowing burden. If there is one thing certain in the science of biology it is that no species or variety of plant or animal has long survived that was intrinsically incapable of making its own living. There is *somewhere* a biological limit to altruism, even for man. A large part of the world today gives the impression that it is determined to find the exact *locus* of that limit as speedily as possible.

IV

Up to this point the discussion has been of the social consequences of firmly established biological principles. In what regions of biology may there be expected with some confidence developments new in principle, and with important implications for human behavior, thought, and social relations? Probably not, one is fairly safe in saying, in such fields as morphology, embryology, or taxonomy. The advances in the field of genetics, which has to a considerable degree dominated biological thought during nearly a half century and will probably continue to for some time yet, will inevitably have an increasing influence on human affairs as the meaning of its advances is better understood. But this influence seems on the whole likely to be more of a negative than positive character—a matter of avoidances, taboos, and prohibitions rather than of positive contributions to human biological progress. Heredity represents the entailed side of biology—things given—about which it is extremely difficult really to *do* anything effective in the face of other compelling elements of human life and living, especially those elements belonging in the psychobiological realm.

It seems probable that advances likely to be made in physiology and psychobiology may profoundly alter human affairs and outlooks

in the not very distant future, and particularly in the direction of the greater release and more effective control of the energies and potentialities of man (and of other living things at will). In recent years the investigations and deductions of the psychiatrists, endocrinologists, and psychobiologists have thrown a beginning glimmer of real light upon the underlying biological bases of the activities and conduct of living things, and especially of man. We are beginning to understand in some detail and particularity how, conduct, normal and abnormal, moral and immoral, is the expression of "animal drives" or urges—themselves resultants of subtle chemical and physiological changes in the body—rather than of either free will or terrestrial and heavenly precepts. It does not seem extravagant to expect that as this understanding broadens and deepens ways may be found to bring it about that men will act somewhat more intelligently and less harmfully in politics, business, society, religion, and elsewhere generally, than they sometimes have in the past. The ever widening and deepening flow of biological knowledge is plainly furnishing a solid, scientific groundwork for a philosophy of life based on releases, in contradistinction to the philosophy of life based upon inhibitions and prohibitions that has so long held us enthralled. I am not unaware that current political philosophies in various parts of the world look backward in this regard, and insist on more prohibitions and regimentations. But they are going against biology, and if I read the history of evolution aright, biology will win. Nature is never in a hurry. And that odd bird the Blue Eagle was much shorter lived than even the poorest dinosaur.

This current trend of biology of which we have just been speaking has many different aspects. There are some who will recall the widespread interest and discussion stirred up many years ago by an essay of the late William James entitled *The energies of men*. It dealt with the release of normally untapped and unsuspected potentialities of men under certain conditions, sometimes those of shock and stress, sometimes under the impulsion of the will. Examples were given of men who, though enfeebled by poor health, performed feats of strength and endurance that would tax the finest athlete, when they encountered conditions that imperatively demanded such a performance.

We are working in the laboratory on another angle of the same general problem. We have experimented with seedlings, grown under very exactly controlled conditions such that all the matter and energy for growth and living (save for water and oxygen) come from the nutri-

tive materials stored in the cotyledons of the seed planted, which themselves are an integral part of the plant. Under these experimental conditions the seedling goes through a complete life cycle of germination, growth, adulthood, senescence, and eventual death. This life cycle corresponds quantitatively very closely to the normal life cycle of the plant in the field, except that it is greatly compressed and fore-shortened in time. By appropriate aseptic surgical procedures we have removed carefully measured parts of the food resources stored in the cotyledons of the cantaloup seeds we have used, and then observed the relative performance of such mutilated seedlings as compared with the normal controls, in respect of growth and duration of life. The net result is to demonstrate that the mutilated plants grow much larger and live many times longer, as compared with the normal controls, than they would be expected to in proportion to the amount of matter and energy for living available to them after the operation. The results indicated clearly that the operated seedlings utilized their available food resources much more effectively than the normal plant does. It is as though an inhibitor had been removed from the plant, freeing its potentialities for more adequate expression.

The possibilities suggested by these experiments seem far-reaching, though admittedly the exploration of the field has only just begun. Work in this direction on plants and lower animals may result in such an understanding of the physiology of releasing normally inhibited biological potentialities as to enable man to unleash effectively and usefully more of his own energies.

In the field of human biology the admitted and crying need is for adequate synthesis of existing knowledge. It is an obvious truism that we know more in detail about the biology of man than about that of any other organism. Anatomists, physiologists, anthropologists, psychologists, sociologists, and economists, have by analytical methods piled up a body of detailed information about man that is literally colossal. But what does it *mean* for humanity? Every thoughtful person will admit that there is a kind of moral necessity to go forward in the attempt to get a better and more comprehensive understanding of the whole nature of man. The material, mechanized civilization he has evolved may easily become a monster to destroy him unless he learns better to comprehend, develop, and control his biological nature. If inventions and discoveries cannot be intelligently managed after they are made, they are likely to be a curse rather than a blessing.

The bulk of scientific effort is, and always has been, directed to-

wards analysis unaccompanied by synthesis. Scientific men have mainly left it to philosophers and literary men to be the synthesisers of their data, shirking the task themselves with a few notable exceptions, of whom perhaps the greatest was a biologist, Charles Darwin. But analysis at best leads only to knowledge; while synthesis may furnish wisdom. And mankind sorely needs more wisdom right here and now!

PHARMACOLOGY.—*The toxicity for sheep of water solutions of hydrocyanic acid and the effectiveness of the nitrite-thiosulphate combination as a remedy.*[1] JAMES F. COUCH, A. B. CLAWSON and H. BUNYEA, Bureau of Animal Industry.

The results of a considerable number of experiments in which solutions of potassium cyanide were administered to sheep have previously been reported.[2,3,4] The potassium cyanide was administered as a drench and the quantity given in each base recorded as milligrams per kilogram of animal weight. In these experiments information was obtained concerning the smallest quantity of potassium cyanide that will produce symptoms in sheep, the smallest quantity that will kill and also concerning the effectiveness of a combination of sodium nitrite and sodium thiosulphate as a remedy for animals poisoned by potassium cyanide.

In the present paper data are presented concerning the toxicity for sheep of hydrocyanic acid in water solution and the remedial effectiveness of the nitrite-thiosulphate combination.

The solution of hydrocyanic acid used was prepared by mixing cold solutions of the calculated quantities of potassium cyanide and of tartaric acid in water and filtering off the precipitated potassium acid tartrate which was washed with a little cold water. The filtrate and washings were combined and diluted to a definite volume. The cyanide content of the solution was then determined by titration with N/10 silver nitrate solution and the strength was adjusted so that one cubic centimeter of solution contained 15.5 mg. of hydrocyanic acid. The solution contained less than 0.05 per cent of dissolved potassium acid tartrate which, in the doses given, was negligible.

A fresh solution was made each morning before experimental work, although analysis showed that there was no appreciable change in the strength of the solution when preserved for 72 hours in a cold place.

[1] Received February 28, 1935
[2] This JOURNAL 24: 369–395. 1934
[3] This JOURNAL 24: 528–532. 1934.
[4] This JOURNAL 25: 57–59. 1935.

TOXIC AND LETHAL QUANTITIES

In all, 29 experiments were made on 20 sheep. In 17 of these no remedies were administered, the experiments being made primarily to determine the effects of various quantities of hydrocyanic acid as compared with those produced by potassium cyanide. The general results obtained in the 17 cases are shown in table 1.

TABLE 1.—QUANTITIES OF HYDROCYANIC ACID GIVEN TO SHEEP AND THE EFFECTS PRODUCED WHEN NO REMEDIES WERE USED

Date 1935	Sheep		Quantities[a] given mg./kg. and effect			
	No.	Weight kg.	Symptoms	Sickness	Death	Remarks
Jan.						
14	1451	34.47			3 38	
14	1462	38.55			3 10	
14	1460	41.72			2.75	
14	1461	43.54			2.74	
14	1463	38.55			2.65	
14	1459	43.99			2 64	
14	1465	33 11			2 63	
14	1452	49.89			2 55	
14	1458	41.72			2 41	
16	1456	35.37			2 32	
18	1474	37 64		2 31		A very poor sheep
14	1464	48.08			2 29	
14	1457	34.92	2.27			
14	1454	46.49		2 03		
14	1453	36 73		1 71		
14	1455	30.84	1 36			
14	1456	35 37	1 05			Very slight effect

[a] The quantities are given as milligrams of hydrocyanic acid per kilogram of animal weight.

The effects produced on sheep 1456 by 1.05 mg. per kg. of animal weight were so mild that the quantity for this animal was apparently very close to the minimum toxic dose. The fact that 2.29 mg. killed while 2.27 mg. produced only symptoms indicates that 2.29 mg. is the approximate minimum lethal dose for sheep. That 2.31 mg. did not kill sheep 1474, a very poor, underweight animal, is not considered as valid evidence against this conclusion. Were the dosage for this animal based on its normal weight when in good flesh, it would be much lower than the figure considered as the minimum lethal dose.

To compare, on a common basis, the toxicity of hydrocyanic acid with that of potassium cyanide, the dosages of the two substances may be reduced to the cyanide (CN) equivalents. On this basis the toxic and lethal doses of cyanide in the two forms are essentially the same.

Following the administration of hydrocyanic acid in 29 cases, symptoms appeared in from 20 seconds to 2 minutes, the average time being 50 seconds. The time to prostration or collapse varied more widely, it being 50 seconds in the shortest case and 51½ minutes in the longest. The longest period was with a sheep given slightly more than 1 m.l.d. Twenty-three cases had an average time of 5 minutes 52 seconds. In the average the animals given the larger quantities showed symptoms and collapsed in a shorter time than those given the smaller doses.

The average time to symptoms in the sheep given 3 to 4 lethal doses was 42 seconds; with those given 1 to 1.5 lethal quantities, it was 55 seconds; and with sheep given toxic but sub-lethal doses, 56 seconds.

The average period to collapse in those sheep given from 3 to 4 lethal quantities was 1 minute 31 seconds, while with those given less than 1.5 minimum lethal doses it was 9 minutes 13 seconds. The longer average was due in part, but not entirely, to the inclusion of two resistant and somewhat unusual cases.

Of the sheep which received no remedy, 11 died. The time between the drenching with cyanide and death varied between 12.5 minutes and 1 hour 22 minutes, and averaged 37 minutes 50 seconds.

RESULTS OF THE ADMINISTRATION OF THE REMEDY

To test the effectiveness of the nitrite-thiosulphate combination as a remedy in cases of poisoning by hydrocyanic acid, 12 experiments were made on 10 sheep. For experimental use a water solution containing 1 gram of sodium nitrite and 2 grams of sodium thiosulphate per 15 c.c. of solution was prepared. Based on 2.29 mg. per kg. as the minimum lethal dose, these animals were given doses of hydrocyanic acid ranging from 3 m.l.d. to 4.0 m.l.d. In periods varying from 0.8 to 4 minutes after being drenched with the cyanide they were then injected intraperitoneally with 15 c.c. of a solution of the nitrite-thiosulphate combination as a remedy.

The results of the administration of the nitrite-thiosulphate combination are shown in table 2.

In 10 cases the remedy was given after the animals had collapsed. Of these, six (or 60 per cent) recovered. One sheep was given the remedy as soon as symptoms were apparent and before collapse, and one was treated at the time of collapse. Both died.

TABLE 2.—SHOWING THE EFFECTS OF THE NITRITE-THIOSULPHATE COMBINATION ADMINISTERED INTRAPERITONEALLY AS A REMEDY FOR SHEEP POISONED BY HYDROCYANIC ACID

Date 1935	Sheep		Dose m.l d.	Time from drench—			Effect
	No.	Weight kg.		To first symptom	To collapse	To giving remedy	
					Minutes		
Jan.							
16	1457	34.92	3	0 5	1 3	1 8	Recovery
14	1469	43 99	3	1 0	1.5	2	do
16	1470	43 54	3	1.0	1 8	2 7	Death
17	1466	35 83	3 1	5	1 3	1 75	do
17	1469	43 99	3 25	.8	1 5	2.5	Recovery
17	1473	40 82	3 25	.75	1 75	2	Death
17	1457	34 92	3 25	.5	2 2	4	Recovery
17	1453	36.73	3 50	.7	1	1 5	do
17	1455	30 84	3 50	.7	1 75	2.	Death
17	1454	46 49	3 75	.75	2	2	do
17	1474	37 64	4.	5	1.	1 5	Recovery
17	1475	40 82	4.	.8 ±	1 8	8	Death

For the sake of comparison with the results obtained using the same remedy for sheep poisoned by potassium cyanide as given in a former paper,[5] table 3 is included. This is a summary of table 2. In it the doses of hydrocyanic acid are arranged in classes, and the number of survivals and deaths in each class shown.

TABLE 3.—EFFECTIVENESS OF THE REMEDY AGAINST VARYING QUANTITIES OF HYDROCYANIC ACID

Dose of HCN m.l.d	Number of animals	Number that survived	Number that died	Per cent survived
3	4	2	2	50
3.25	3	2	1	67
3 5	2	1	1	50
3.75	1		1	0
4	2	1	1	50
Total	12	6	6	50

From table 3 it will be noted that the remedy was 50 per cent effective against as much as 4 minimum lethal doses of hydrocyanic acid. When compared with the results obtained with sheep poisoned by potassium cyanide, in which 2.75 m.l.d. was the largest dose against which protection was secured in 50 per cent or more of the cases,[6] it would appear that the remedy is more effective against poisoning by hydrocyanic acid itself than against poisoning by potassium cyanide.

[5] This JOURNAL 24: 369–395 1934

[6] This JOURNAL 24: 369–395. 1934.

SUMMARY

When administered in sheep in a drench the minimum toxic dose of pure hydrocyanic acid is shown to be approximately 1.05 mg. per kg. of animal weight, and the minimum lethal dose is approximately 2.29 mg. per kg. When compared on a cyanide (CN) basis the differences in toxicity between hydrocyanic acid and potassium cyanide are slight and well within the limits of experimental error.

Following the administration of pure hydrocyanic acid, symptoms appear in an average of 50 seconds. The time to collapse is very variable. In the cases here reported the average time was 5 minutes 52 seconds. When no remedy was given the average time to death was nearly 38 minutes.

The nitrite-thiosulphate combination was 50 per cent effective as a remedy against from 3 to 4 m.l.d., and when injected intraperitoneally within 4 minutes after the hydrocyanic acid was administered.

GEOLOGY.—*Notes on the structure of the Erin shale of Alabama.*[1] C. F. PARK, JR., U. S. Geological Survey. (Communicated by W. W. RUBEY.)

ABSTRACT

The Erin shale of east-central Alabama has previously been mapped as a stratigraphic unit in the Talladega slate Fossils found in the Erin shale have been the basis for assigning a Carboniferous age to part or all of the Talladega slate and other crystalline rocks in the eastern part of the State Evidence is presented to show that the contact between the Erin shale and the Talladega formation is a thrust fault dipping at a low angle eastward. The Erin shale is exposed by erosion through the overthrust block.

The type locality of the Erin shale of east-central Alabama is an area about 6 miles long and less than 1 mile wide. The exposure is in the valley of Talladega Creek along the east base of the Talladega Mountains in Clay County, Ala., about 8 miles northwest of Ashland. The Hillabee chlorite schist and the Ashland mica schist lie east of the Talladega formation (fig. 1). The Wedowee formation is east of the Ashland schist but is not shown on the map.

The Erin shale was described in 1903 by E. A. Smith, who considered it a lenticular mass in the Talladega slate, which he called "Ocoee."[2] Fossil plants were collected by Dr. Smith from the Erin shale and were determined by David White to be of Carboniferous age. Practically all papers treating of the Talladega slate that have appeared since 1903 have assigned a Carboniferous age to at least

[1] Published by permission of the Director, U. S. Geological Survey. Received March 30, 1935.

[2] SMITH, E. A. Science, new ser., 18: 244–246. 1903.

part of the formation, on the assumption that the Erin shale is stratigraphically enclosed in the Talladega. As a result of study of the relations between the Talladega formation and the crystalline rocks to the east (the Hillabee schist, the Ashland schist, and the Wedowee formation) the several crystalline formations have been assigned to periods ranging from pre-Cambrian to Carboniferous.[3]

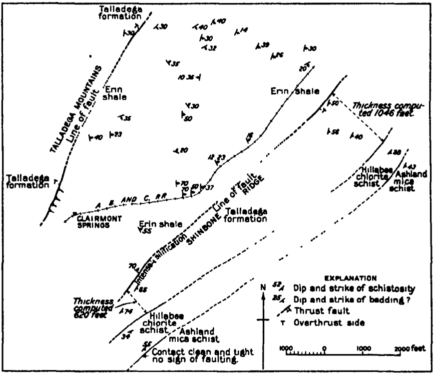

FIG. 1.—Sketch map of part of the Erin shale, showing relation to the Talladega formation.

Slightly altered Erin shale is exposed in numerous cuts along the Atlanta, Birmingham & Coast Railroad. This shale is a fine-grained black material that in thin sections shows a few small grains and bands of fine quartz in a carbonaceous matrix. Nothing is seen that would indicate that the rock had been metamorphosed except the

[3] PROUTY, W. F. *Geology and mineral resources of Clay County, Ala* Alabama Geol. Survey County Rept. 1: 38-41, 61–63. 1923; *Age of Talladega slates of Alabama.* Pan-Am. Geologist 37, n. 5: 363–366. 1922.

ADAMS, G. I. *Geology of Alabama.* Alabama Geol. Survey Special Rept **14**: 30, 33, 36–39. 1926.

BUTTS, CHARLES, idem, 59–61, 217–219.

BROWN, J. A., *Graphite deposits of Ashland, Ala.* Econ. Geology. **20**: 208–229. 1925.

shale parting planes; no evidence of recrystallization is found. The Talladega formation is, by contrast, a thinly laminated schist composed almost entirely of sericite and quartz with a little chlorite; it is much more intensely metamorphosed than the Erin shale and appears to be almost entirely recrystallized. Both the Erin shale and the Talladega formation weather to a white or buff clay, but the outcrops of weathered Talladega schist generally contain some partly altered mica. The fact that the Erin shale weathers white or buff indicates that the carbon present has not been fixed as graphite. Graphite is a common constituent of the Ashland and Wedowee schists and is known to occur in the Talladega formation. West of the Erin shale the Talladega formation contains beds of quartzite and conglomerate in addition to the schist.

There is a discordance in strike between the cleavage in the Erin shale and the schistosity in the Talladega formation, locally amounting to nearly 90°. The Talladega formation just east of the eastern contact with the Erin shale is intensely silicified and rises in a cliff that in places is about 30 feet high. The Talladega formation is wedge-shaped in outcrop; near the northeastern border of the area mapped its thickness is about 1,000 feet and near the southwestern border, about 600 feet. This wedge-shaped block has been explained by Adams as the result of a thrust fault between the Talladega formation and the Ashland mica schist to the east. The Hillabee schist is considered to be a basic rock intruded along this thrust plane.[4] The schistosity in the Talladega is approximately parallel with that in the Hillabee and Ashland schists, but the strikes in the Talladega and the Erin are divergent.

It has been stated by Charles Butts that C. W. Hayes considered the Erin shale to be an infolded bed in the Talladega slate. Butts' notes, however, indicate a fault along the southeast contact of the Erin shale and the Talladega slate, but he states that Hayes' interpretation seems equally probable.[5] C. W. Hayes and David White concluded, after field study, that the Erin shales were unconformable with the Talladega slates.[6] Miss Jonas has recently described and mapped the Erin shale as a fenster in the Talladega slate but does not discuss it in detail.[7]

[4] ADAMS, G. I. op. cit., p. 38.
[5] BUTTS, CHARLES. Personal communication, January, 1935.
[6] McCASKEY, H. D. *Some gold deposits of Alabama.* U. S. Geol. Survey Bull. 340: 38. 1908.
[7] JONAS, A. I. *Structure of the metamorphic belt of the Southern Appalachians.* Am. Jour. Sci. 24: 243. 1932. Geological map of the United States, southeastern quarter. U. S. Geological Survey, 1934.

There is sufficient evidence to indicate a fault between the Talladega formation and the Erin shale in this area. The evidence also justifies the suggestion that the Talladega formation has been thrust over the Erin shale along a fault plane that dips slightly eastward (3°–5° as determined by differences in altitude along the contracts). The Erin shale is thought to have been exposed by erosion of the thin overthrust plate, thus forming a window. The faulting along the line of outcrop of the Hillabee schist is considered a complementary thrust fault in the overthrust block. The mineralization along the fault in the Hillabee schist is therefore thought to be post-Erin shale. The assignment of part of the Talladega slate and other crystalline rocks in eastern Alabama to an age as recent as the Carboniferous, on the supposition that the Erin shale is a lenticular mass originally deposited in the Talladega, is believed to be unwarranted by the field relations here described.

ENTOMOLOGY.—*Three new reared parasitic Hymenoptera, with some notes on synonymy.*[1] C. F. W. MUESEBECK, Bureau of Entomology and Plant Quarantine. (Communicated by HAROLD MORRISON.)

The new species described below have been reared in the course of studies in economic entomology. In order to make the names available for use the descriptions are published at this time.

SERPHOIDEA

SCELIONIDAE

Telenomus catalpae, new species

In the female sex very similar to *sphingis* Ashmead, but distinguished by having the occipital carina only very narrowly interrupted at the middle, by the yellowish mouth region, and by the somewhat stouter thorax. In the male sex at once distinguished from all related species by the entirely reddish-yellow head and thorax

Female.—Length, 1 mm. Head transverse, more than twice as broad as long; viewed from in front much broader than long; eyes finely hairy, rather strongly divergent below; frons smooth, delicately reticulated laterally below middle of eyes; malar space half as long as scape; vertex finely reticulate, punctate and subopaque; ocelli in a low triangle, the lateral ones touching the eyes; temples flat, polished except for a narrow reticulated border along the eyes; antennae 11-segmented; scape not reaching summit of vertex; pedicel at least one-third as long as scape; first segment of funicle distinctly a little shorter than pedicel; second and third segments of funicle subequal, shorter than first and barely or not longer than broad; fourth shorter than second or third and about as wide as these; fifth to ninth seg-

[1] Received March 20, 1935.

ments forming a distinct club, the fifth much the smallest, strongly transverse and somewhat narrower than the following; sixth, seventh and eighth subequal, distinctly somewhat broader than long, the apical segment conical.

Thorax narrower than head; mesoscutum evenly convex, minutely reticulate punctate, finely hairy and subopaque; scutellum smooth and polished; metanotum finely sculptured and opaque at the middle; propodeum with a prominent oblique carina on each side from near middle of base of propodeum to a point beyond middle of lateral margin; stigmal vein more than twice as long as marginal and about half as long as postmarginal; submarginal vein with about 10 long setae.

Abdomen hardly shorter than thorax and nearly as broad, more or less truncate at apex; first tergite four times as broad as long at the middle, smooth and polished except for a row of elongate pits bordering the basal margin; second tergite about one and one-half times as long as broad, smooth and polished except for a row of foveae at the base and a few weak short striulae medially at base; remaining tergites very short; ovipositor sheath slightly exserted.

Black; mandibles, clypeus, and a spot between bases of antennae yellowish; scape black, pale at apex; remainder of antenna dark brown; all coxae and femora blackish; anterior tibiae pale, the middle and posterior pairs more or less infuscated; tarsi brownish yellow, the apical segment black; wings hyaline.

Male.—Essentially like the female except in the structure of the antennae and in color. Antennae 12-segmented; pedicel and basal three flagellar segments subequal, slightly longer than broad, fourth to ninth flagellar segments shorter, moniliform; the apical segment conical. Reddish yellow; antennae and legs a little paler; apical half of abdomen more or less blackish.

Type locality.—Takoma Park, Md.

Type.—U. S. National Museum No. 50795.

Host.—Eggs of *Ceratomia catalpae* Bdv.

Described from 32 females and 51 males (type, allotype, and paratypes) reared by J. W. Bulger at the type locality September 27, 1932; and 2 females and 3 males, likewise reared from eggs of *C. catalpae*, by W. J. Baerg, August 5, 1933, at Fayetteville, Ark.

ICHNEUMONOIDEA

Braconidae

Apanteles epiblemae, new species

This species is exceedingly similar to *epinotiae* Viereck, with which it is easily confused. It may be distinguished from that species, however, by its complete and strong propodeal costulae, by its relatively longer intercubitus, by its more definitely punctate face, mesoscutum, and mesopleurum, by the prominence of the posterior lateral angles of the propodeum, and by its longer ovipositor.

Female.—Length, 2.5 mm. Head strongly transverse, temples narrow; face flat, definitely closely punctate and subopaque; malar space equal to basal width of mandible; eyes long; vertex minutely punctate, opaque; ocellocular line and postocellar line subequal, twice the diameter of an ocellus, antennae slightly shorter than body.

Thorax, stout, broader than head; mesoscutum finely confluently punctate, minutely longitudinally rugulose posteriorly; disk of scutellum longer than broad at base, smooth and polished; polished areas on lateral face of

scutellum very large, triangular, extending nearly to the base; propodeum finely rugulose, with a large, sharply margined median areola which is open at the base and is traversed by several low transverse rugae, and with strong, complete costulae; posterior lateral angles of propodeum very prominent; mesopleurum anteriorly confluently punctate and opaque; first abscissa of radius about one and one-half times as long as transverse cubitus; metacarpus distinctly longer than stigma; nervellus strongly curved; posterior coxae smooth; inner calcarium of posterior tibia hardly half as long as basitarsus.

Abdomen a little narrower than thorax; first tergite considerably longer than broad, nearly parallel sided, truncate at apex, closely rugulose; plate of second tergite strongly transverse, longest at the middle, its median length about one-fourth its apical width, very weakly, indefinitely sculptured; third and following tergites polished, the third much longer than the second; ovipositor sheath slender, fully as long as the abdomen and as long as posterior tarsus.

Black; palpi pale; anterior legs beyond trochanters testaceous; middle femora apically, middle tibiae and posterior tibiae, except at apex, and middle tarsi, except apical segment, reddish-yellow; tegulae yellowish-white; wings whitish hyaline; stigma hyaline margined with brown; veins mostly hyaline; costa whitish; metacarpus brown

Male.—Like the female in all essential respects; however, the second tergite is smoother, the legs, especially the middle and posterior tibiae, are darker; and the antennae are longer than the body.

Type locality.—Meade County, Kans.

Type.—U. S. National Museum No. 50796.

Host.—*Epiplema strenuana* Walker.

Described from 7 females and 6 males. The type, allotype, and one male and one female paratype reared in February 1933 from the above-named host at the type locality by Sam G. Kelly; three males and one female from Clark County, Kans., likewise reared by Mr. Kelly in February 1933; one male from Riley County, Kans., and one female from Manhattan, Kans., reared by Mr. Kelly in August 1933; one female from Bridgeville, Del., reared from *E. strenuana* by A. O. Baker, August 10, 1933; one female reared from the same host by William Rau Haden at Camden, Del., August 14, 1933; and one female reared from *Grapholitha molesta* Busck by O. I. Snapp, of the Bureau of Entomology and Plant Quarantine, at Fort Valley, Ga., June 16, 1925, under Quaintance No. 21938. In the female paratypes the color of the legs ranges from almost entirely testaceous beyond trochanters to mostly black.

Apanteles thujae, new species

In my key to the Nearctic species of *Apanteles*[2] this species runs directly to *monticola* Ashmead, which it very closely resembles. It may be distinguished from that species, however, by its somewhat depressed thorax, shorter malar space, punctate scutellum, and the rugulose punctate, rather than more or less striate, sculpture of the basal two abdominal tergites.

Female.—Length, 1.8 mm. Head slightly narrower than thorax; eyes a little convergent below; malar space shorter than basal width of mandible; face smooth and shining, with only indistinct setiferous punctures; temples narrow but convex; ocell-ocular line twice diameter of an ocellus; antennae about as long as body.

[2] Proc. U. S. Nat. Mus. 58: 487. 1920.

Thorax stout, distinctly somewhat depressed; mesoscutum broader than long, opaque, evenly, minutely, and shallowly punctate; suture at base of scutellum very narrow, minutely foveolate; scutellum flat, subopaque, sculptured like mesoscutum though more weakly; propodeum convex, more than twice as broad as long, without a median areola, smooth and shining, with only a little weak rugulosity along posterior margin; mesopleurum smooth and polished except anteriorly, where there are some shallow punctures; inner calcarium of posterior tibia not longer than outer and not quite half as long as metatarsus; stigma slightly shorter than metacarpus; radius issuing from middle of stigma, perpendicular to anterior margin of wing and slightly longer than intercubitus.

Abdomen narrower than thorax; chitinized plate of first tergite narrowing a little toward apex, twice as long as broad at apex, gently excavated at base, where it is smooth and polished, the apical two-thirds finely rugulose punctate, and with a more or less distinct, though very narrow and shallow, median longitudinal groove on posterior half; lateral membranous margins of first tergite very broad on apical half; plate of second tergite strongly transverse, more than three times as broad on posterior margin as long, defined laterally by indistinct oblique grooves, more weakly sculptured than first tergite, its posterior margin straight; following tergites smooth and shining; ovipositor sheath at least as long as posterior femur but hardly as long as posterior tibia, rather strongly broadened toward apex; ovipositor a little decurved at apex.

Black; antennae entirely black, also tegulae; apex of anterior femur, more or less of anterior tibia, the anterior and middle tarsi, and posterior tibia at extreme base, yellowish brown; calcaria of tibiae whitish; wings clear hyaline, stigma and veins brown.

Male.—Essentially like female, but having antennae considerably longer than body.

Type locality.—Bar Harbor, Maine.

Type.—U. S. National Museum No. 50797.

Host.—*Recurvaria thujaella* Kearfott.

Described from seventeen females and one male (Type, allotype, and 16 paratypes) reared by A. E. Brower at type locality July 15–19, 1933, and two females, likewise reared by Dr. Brower, July 8, 1933, at Mt. Desert Island, Maine.

(*Macrocentrus laspeyresiae* Mues.) = *Macrocentrus instabilis* Mues.

Macrocentrus instabilis Muesebeck, Proc U S. Nat Mus. **80**: 34 1932.
Macrocentrus laspeyresiae Muesebeck, loc cit., p 37 (new synonymy).

Since the publication of the paper in which *instabilis* and *laspeyresiae* were described I have seen a large number of additional specimens, reared from *Grapholitha molesta* Busck and *Carpocapsa pomonella* L This material exhibits complete intergradations between typical *instabilis* and typical *laspeyresiae*, and has convinced me that the two are merely variants of an extremely variable species.

(*Aneurobracon* Brues) = *Mesocoelus* Schulz

Coelothorax Ashmead (not *Coelothorax* Anceys). Proc. Ent. Soc. Wash. **4**: 165. 1898.

Mesocoelus Schulz, Zool. Ann. 4: 88. 1911.
Aneurobracon Brues, The African Republic of Liberia and the Belgian Congo, based on the Harvard African Expedition, 2: 1002 (new synonymy).
Mesocoelus Muesebeck, Proc. Biol. Soc. Wash. 45: 227. 1932.

At the time of my brief discussion of this genus I had not seen the paper by Brues in which *Aneurobracon* was described. His description and figures leave no doubt that the genotypic species, *Aneurobracon bequaerti*, is congeneric with the genotype of *Mesocoelus*. It appears to be very similar to *philippinensis* Mues., but differs in the complete absence of a medius and the slightly longer antennae.

ENTOLOMOGY.—*An undescribed rubber tingitid from Brazil (Hemiptera).*[1] C. J. DRAKE and M. E. POOR, Iowa State College. (Communicated by HAROLD MORRISON.)

Through the kindness of Mr. H. G. Barber of the U. S. Bureau of Entomology, the writers have received a series of 40 specimens of an undescribed species of lace bug from Brazil. The insect was taken in large numbers on the leaves of the rubber tree, *Hevea braziliensis* Muell. Arg.

Leptopharsa heveae, sp. nov Fig. 1.

Elongate, moderately broad, whitish. Antennae very long, dark brown to brownish black, clothed with numerous fine, short, pale hairs; segment I long, moderately stout, almost straight, nearly six times as long as II, the latter very short; III very long, slender, nearly straight, two and a half times the length of one; IV very long, slender, scarcely stouter than three, clothed with longer hairs, one and one-half times the length of one. Head brown, largely covered with whitish exudation, armed with five long, pale testaceous spines; frontal spines sub-porrect, blunt, the tips contiguous; median and lateral spines more or less resting on the surface of the head. Bucculae whitish, reticulate, closed in front. Rostral laminae widely separated on meso- and metanotum; rostrum extending on the basal portion of mesosternum. Orifice distinct.

Body beneath ferrugineous, more or less covered with whitish exudation. Legs long, slender, testaceous, the tarsi darker. Pronotum moderately tumid, deeply and closely pitted, reticulate on triangular portion, tricarinate; median carina thicker and more strongly elevated, without distinct areolae; lateral carinae distinct, sub-parallel, faintly converging posteriorly. Paranota moderately broad, biseriate, moderately reflexed, the lateral margin rounded and finely serrate. Collum distinct, raised at the middle, reticulate. Calli black, often covered with white exudation. Elytra widening posteriorly, finely serrate along the costal margin, extending considerably beyond tip of abdomen, the areolae not very large and clear; costal area broad, mostly quadriseriate, with five rows at widest part, the areolae not arranged in very regular rows; subcostal area narrow, biseriate; discoidal area moderately

[1] Received March 22, 1935.

large, faintly impressed, not quite reaching middle of elytra, narrowed at apex, with five to six rows of areolae at widest part; sutural area rather widely reticulated. Wings subequal to abdomen in length.

Length, 4.00–4.20 mm.; width, 1.35–1.50 mm.

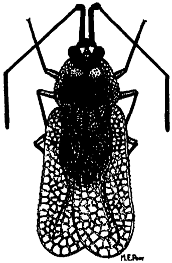

Fig. 1.—*Leptopharsa heveae* sp. nov., *type*, ♂.

Holotype, male, and allotype, female, Boa Vista Rio Tapajo, Brazil, on leaves of rubber tree, collected by Dr. C. H. T. Townsend. Paratypes, taken with type and from Para, Brazil, on rubber tree, taken by H. W. Moore. Types in U. S. National Museum.

This is the first record of a tingitid pest of the rubber plant. It is a very distinct species and probably most closely allied to *L. abella* Drake from Brazil. From the latter or other closely allied forms, *L. heveae* may be distinguished by its larger size, white color and wider costal area. The genus *Leptopharsa* Stål contains about 70 described species, largely from tropical America.

BOTANY.—*The genus* Cremosperma.[1] C. V. Morton, National Museum. (Communicated by William R. Maxon.)

Bentham's genus *Cremosperma* has always been considered as doubtfully valid. Thus, Hanstein in his monograph of the family Gesneriaceae[2] listed it among the dubious genera; Bentham and Hooker[3] reduced it to a section of *Besleria;* and Fritsch,[4] although he

[1] Published by permission of the Secretary of the Smithsonian Institution. Received March 11, 1935.

[2] Linnaea 34: 429 1865.

had seen no specimens, listed it a doubtful genus related to *Besleria*. Very recently Fritsch[5] has described as new *Besleria* (*Cremosperma*) *cinnabarina*, reducing the genus to *Besleria* outright.

For some time I have been engaged in a monographic study of *Besleria* and have had an opportunity to examine most of the species. During this investigation I came across numerous specimens of *Cremosperma*, which had been variously identified as belonging to the genera *Besleria*, *Episcia*, *Achimenes*, *Tydaea*, and *Koellikeria*, all of which (with the exception of *Besleria*) are quite remotely related. These specimens, all from the Andes of Colombia and Ecuador, were distinguished by a low herbaceous habit and a distinctive racemose-capitate inflorescence, and were obviously congeneric with Bentham's *Cremosperma hirsutissimum*.

Further study has convinced me that *Cremosperma* represents a perfectly valid generic type, perhaps of not even very close affinity with *Besleria* in spite of the similar disk and anthers of both. In addition to a very different habit and inflorescence, the species of *Cremosperma* all have small, usually pale-colored corollas with widely flaring limb and usually non-ventricose tube. The usually highly colored corollas of *Besleria* have a small inconspicuous limb except in the two species belonging to the subgenus *Macrobesleria*, in which the corolla lobes are larger and patent; in these two species, however, the corolla tube is markedly ventricose and the plants are otherwise very different from *Cremosperma*. The calyx also differs from that of any species of *Besleria*, being turbinate or cylindric-turbinate with short equal lobes and ten conspicuous costae, these in a few species sometimes obscured by the dense pubescence. The fruits of *Cremosperma* will apparently afford technical characters of importance also. Those of *Besleria* are fleshy berries with a thick skin. Bentham originally described those of *Cremosperma* as capsules opening by two valves, but an examination of the few mature fruits available indicates rather that they are capsules with thin membranous walls, not really two-valved but rupturing irregularly. I have not been able to study any mature seeds.

The number of species must now be increased from two to ten and there are indications that further exploration of Colombia will reveal still others. The species are apparently very local in distribution and many are known from a single collection only.

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[3] Genera Plantarum 2: 1016 1876.
[4] Engl. & Prantl Pflanzenfam. 4^{3b}: 159 1895.
[5] Notizbl. Bot. Gart Berlin 11: 976. 1934

Cremosperma Benth.[6]

Herbae perennes vel fruticuli perpusilli, caulibus erectis vel adscendentibus vel repentibus. Folia opposita vel quaternata, aequalia vel inaequalia, saepe ovata vel elliptica, interdum orbicularia vel oblanceolata, plerumque basi subcordata, saepe hirsuta, petiolata, paucinervata. Inflorescentia racemoso-capitata (vel raro flores solitarii?). Pedunculus communis brevis vel elongatus. Calyx tubulosus, turbinatus vel cylindrico-turbinatus, 10-costatus, lobis parvis, erectis, integris, acutis. Corolla alba, flava vel raro rubescens vel coccinea (?), parva, tubo cylindrico vel infundibuliformi, lobis magnis, patentibus, rotundatis. Stamina 4, didynama, loculis confluentibus. Annulus hypogynus annularis vel semi-annularis, glandulis discretis nullis. Ovarium glabrum. Capsula subglobosa, membranacea, irregulariter dehiscens.

TYPE SPECIES: *Cremosperma hirsutissimum* Benth.

KEY TO SPECIES

Flowers racemose-capitate on a common peduncle. Mostly lowland species.

Leaves mostly borne in whorls of 3 or 4, equal, acute at base and apex.

Corolla white, the tube ampliate upwardly; calyx lobes deltoid . . . . . . **1. C. pusillum.**

Leaves opposite, never in whorls.

Leaves of a pair unequal, the smaller one much reduced, sometimes auriculiform; corolla tube hardly at all ampliate

Larger leaves oblanceolate, acute at base, glabrate above; calyx lobes ovate-deltoid; disk reduced to a bilobed posterior gland. . . . **2. C. congruens.**

Larger leaves obliquely oval, obliquely subcordate at base, densely sericeous-pilose above; calyx lobes linear-lanceolate; disk annular . . . **3. C. cotejense.**

Leaves of a pair equal, subcordate or rounded at base; corolla tube ampliate (except in *C. Castroanum*).

Calyx glabrous, except for the ciliate lobes, glaucous; common peduncle about 10 cm. long; corolla reddish, glabrous . . . . . **4. C. jucundum.**

Calyx hirsute or hirsutulous, not glaucous; common peduncle not more than 5 cm. long; corolla white or yellow, pilose.

Corolla 8–10 mm long, yellow, the lobes 1.5–2 mm. long. Leaves ovate or elliptic, not tuberculate above.

Leaves glabrous above; calyx lobes deltoid, much shorter than the calyx tube . . . . **5. C. ignotum.**

Leaves hirsute above; calyx lobes lanceolate, almost equaling the calyx tube . . . **6. C. Castroanum.**

Corolla 12–15 mm. long, the lobes 3–6 mm. long.

Calyx about 8.5 mm. long.

Leaves elongate-tuberculate above, about 4.5 cm. long; calyx lobes linear-lanceolate . . . **7. C. nobile.**

[6] Plant. Hartw. 234. 1846.

Leaves not tuberculate above, 7.5–8.5 cm. long; calyx lobes oblong . . . . **8. C. hirsutissimum.**

Calyx about 5.5 mm. long, the lobes ovate, broad. Leaves not tuberculate above, suborbicular, up to 6.2 cm. wide; corolla white . . . . **9. C. album.**

Flowers aggregate in the leaf axils, a common peduncle absent. Calyx deeply parted, the lobes lanceolate; corolla deep red High mountain species. . . . . **10. C. cinnabarinum.**

1. Cremosperma pusillum Morton, sp. nov.

Frutex pusillus, usque ad 20 cm. altus; caules crassi, teretes, hirsuti, internodiis brevissimis, nodis perspicuis; folia ternata vel quaternata, aequalia, parva, lamina anguste elliptica, maxima ca. 20 mm. longa et 7 mm. lata, evidenter crenata, basi apiceque acuta, supra sparse hirsuta, saepe bullata, subtus reticulata, imprimis in nervis villosa (nervis secundariis 4 vel 5 jugis), petiolata, petiolo usque ad 15 mm. longo, hirsuto, gracili; pedunculus communis tenuis, usque ad 3 cm. longus, glaber vel sparse pilosus; flores racemoso-capitati, pauci, pedicellis usque ad 4 mm. longis, parce pilosis; calyx campanulatus, ca. 5 mm. longus, sparse pilosus, tubo 2.5–3 mm. longo, lobis deltoideis, obtusis; corolla alba, erecta, tubo cylindrico, ca. 11 mm longo, ca. 2 mm. lato, sursum ampliato et ca. 4 mm. lato, extus glabro vel parce piloso, lobis magnis, ca. 5 mm. longis et 4 mm. latis, patentibus, rotundatis, utrinque glabris; ovarium glabrum; stylus glaber; discus tenuis, altus, uno latere interruptus; fructus deest.

Type in the Kew Herbarium, collected at Tambo de Savanilla, probably Province of Nariño, Colombia, Dec. 18, 1876, by E. André (no. 4572); duplicate in the New York Botanical Garden. A second collection of this species is *Kalbreyer* 1470, in the Kew Herbarium, collected in the Province of Antioquia, Colombia. This agrees in all particulars with the André specimens.

Easily distinguishable by its very small ternate or quaternate leaves, in contrast to strictly opposite leaves of the other species.

A somewhat larger specimen collected in Ecuador by Jameson appears varietally distinct:

var. **ecuadorense** Morton, var. nov.

Differt a var. *typica* foliis majoribus (usque ad 5.3 cm. longis et 2 7 cm. latis), magis hirsutis, calycibus longioribus (ca. 9 mm. longis) et disco annulari nec interrupto.

Type in the Kew Herbarium, collected on Mt. Pichincha, Ecuador, ca. 1,800 meters altitude, Jan. 21, 1856, by W. Jameson.

2. Cremosperma congruens Morton, sp. nov

Herba parva, usque ad 15 cm. alta; caules teretes, strigosi, internodiis brevibus; folia opposita, cujusve paris saepe valde inaequalia, alterum lamina oblanceolata, usque ad 3.5 cm. longa et 1.4 cm. lata, apicem versus serrata, acuta, basi attenuata, supra primum parce pilosa, mox glabrata, subtus imprimis in nervis strigosa (nervis secundariis ca. 6 jugis), petiolata (petiolo brevi, usque ad 3 mm. longo, strigoso), alterum parvum vel auri-

culiforme, lanceolatum, integrum, vix petiolatum; pedunculus communis tenuis, usque ad 27 mm. longus, glaber vel parce pilosus; flores racemoso-capitati, pedicellis brevibus vel usque ad 7 mm. longis, pilosis; calyx turbinatus, 4.5 mm. longus, sericeo-strigosus, tubo 3.5–4 mm. longo. intus glabro, lobis ovato-deltoideis, obtusis; corollae tubus erectus, cylindricus, ca. 7 mm. longus et 1.5 mm. latus sursum non ampliatus, extus pilosus, lobis magnis, ca. 3 mm. longis et 2 mm. latis, patentibus, rotundatis; filamenta libera, glabra; antherae parvae, connatae; ovarium globossum, glabrum; stylus glaber; stigma capitatum; discus in glandulam posticam bilobam reductus.

Type in the U. S. National Herbarium, no. 1,185,005, collected at Paime, Department of Cundinamarca, Colombia, altitude about 1,000 meters, by Brother Ariste Joseph (no. A923). There is in the Hooker Herbarium at Kew another specimen of this species collected at the same locality by Goudot.

3. Cremosperma cotejense Morton, sp. nov.

Herba parva, usque ad 30 cm. alta; caules crassi, teretes, sparse pilosi; folia herbacea, cujusve paris valde inaequalia, alterum oblique ovale, usque ad 6 cm. longum et 2.5 cm. latum, serratum, apice acutum, basi oblique subcordatum, supra dense pilosum, subtus imprimis in nervis pilosum (nervis secundariis ca. 4 jugis), petiolatum, petiolis gracilibus, usque 12 mm. longis, alterum auriculiforme, ca. 8 mm. longum, parum serratum, vix acutum, basi subcordatum, vix petiolatum; pedunculus communis usque ad 2.5 cm. longus gracilis, sparse pilosus; flores racemoso-capitati, pedicellis brevissimis, ca. 2 mm. longis, gracilibus, sparse pilosis; calycis tubus ca. 2 mm. longus, angustus, extus hirsutus, intus glaber, lobis lineari-lanceolatis, ca 2 mm. longis, hirsutis; corollae tubus ca. 4 mm. longus, ca 1 mm. latus, anguste cylindricus, sursum vix ampliatus, glaber, in calyce inclusus, lobis ca. 3 mm. longis, patentibus, albis, extus pilosis; antherae in fauce dispositae, connatae, parvae; filamenta glabra; ovarium glabrum; stylus glaber; discus annularis, integer, glaber; fructus deest.

Type in herbarium of the New York Botanical Garden, collected in dense, damp forests around Coteje on Rio Timbiqué, Province of Cauca, Colombia, altitude 100–500 meters, by F. C. Lehmann (no. 8888).

Lehmann's field note reads as follows: "Stems up to 30 cm. in length, poorly ramified, procumbent at base. Leaves soft herbaceous, black-green, on the upper side with a greasy sheen. Flowers white."

4. Cremosperma jucundum Morton, sp. nov

Herba vix 15 cm. alta; caules crassi, teretes, lanati; folia opposita, fere aequalia, lamina ovata, usque ad 10 cm. longa et 6 cm. lata, membranacea, leviter crenata, apice rotundata, basi subcordata, supra hirsuta, paullulum bullata vel tuberculata, subtus imprimis in nervis lanata, nervis secundariis ca. 6 jugis; petiolus brevis, usque ad 7 mm. longus, crassus, dense hirsutus; pedunculus communis elongatus, usque ad 10 cm. longus, gracilis, hirsutus; flores racemosi-capitati, numerosi, pedicellis ca. 6 mm. longis, fere glabris, glaucescentibus, apice incrassatis; calyx campanulato-turbinatus, ca. 4.5 mm. longus, glaber, glaucus, lobis deltoideis, ciliatis; corolla rubescens, glabra, ca. 11 mm. longa, tubo cylindrico, sursum gradatim ampliato, non ventricoso, lobis magnis, patentibus, rotundatis; ovarium glabrum; discus annularis, integer, glaber.

Type in the Kew Herbarium, collected in the Province of Antioquia, Colombia, in 1879, by Kalbreyer (no. 1821). Kalbreyer's field note reads: "Herb in tufts; leaf blackish-green with velvety lustre; flowers in umbels, reddish. Forest shade, 2,700–3,000 feet."

5. Cremosperma ignotum Morton, sp. nov.

Herba parva, usque ad 9 cm. alta, caules perbreves, lanati; folia opposita, cujusve paris aequalia, elliptica, maxima 5.8 cm. longa et 3.2 (raro 3.8) cm. lata, membranacea, integra vel parum denticulata, apice acuta vel rotundata, basi subcordata, supra glabra, subtus imprimis in nervis appresso-pubescentia (nervis secundariis ca. 4 jugis), breviter petiolata, petiolo crasso, ca. 7 mm. longo, lanato; pedunculus communis tenuis, usque ad 4 cm. longus, fere glaber vel parce pilosus; flores racemoso-capitati, pedicellis brevibus vel usque ad 3.5 mm. longis, pilosis; calyx turbinatus, ca. 3.5 mm. longus, 10-costatus, imprimis in costis strigosus, tubo ca. 2.5 mm. longo, lobis ca. 1 mm. longis, deltoideis, acutis, paullulum inaequalibus; corolla flava, 8–10 mm. longa, extus parce pilosa, tubo cylindrico, fauce ampliato, lobis ca. 2 mm. longis, patentibus, rotundatis; antherae parvae, connatae; ovarium glabrum; discus annularis, altus, integer, fructus deest.

Type in the herbarium of the Academy of Natural Sciences, Philadelphia, no. 642,556, collected in forest along Rio Caballete, Santa Rosa, Dagua Valley, Department of El Valle, Colombia, altitude 200–300 meters, Sept. 22, 1922, by E. P. Killip (no. 11540) A duplicate is in the herbarium of the New York Botanical Garden.

6. Cremosperma Castroanum Morton, sp nov.

Herba erecta, usque ad 20 cm. alta; caules crassi, teretes, dense hirsuti; folia opposita, aequalia, lamina ovata vel elliptica, usque ad 9.5 cm. longa et 6 cm. lata, membranacea, dentata, apice late obtusa vel rotundata, basi rotundata, supra hirsuta, plana, subtus pilosa, nervis secundariis ca 5 jugis; petiolus usque ad 3 cm longus, hirsutus; pedunculus communis usque ad 5 cm. longus, tenuis, pilosus; flores racemoso-capitati, numerosi, pedicellis brevissimis, 2–2.5 mm. longis, pilosis; calyx cylindrico-turbinatus, ca. 5 mm. longus, hirsutus, intus glaber, lobis lanceolatis, tubum fere aequantibus; corolla flava, parva (usque ad 8.5 mm. longa), sparse pilosa, tubo cylindrico, ca. 2 mm. lato, sursum vix ampliato, lobis semioblongis, 1.5 mm. longis, rotundatis, patentibus; filamenta tenuia, glabra; antherae parvae; ovarium glabrum, stylus glaber; stigma capitatum; discus annularis, brevis, integer, glaber.

Type in the U. S. National Herbarium, no. 1,517,374, collected at Tutunendo, 20 kilometers north of Quibdó, Intendencia de Chocó, Colombia, altitude 80 meters, May 19–20, 1931, by W. A. Archer (no. 2151). I have seen the following additional collections, all from the Intendencia de Chocó: *Triana* 2546; *R. B. White* s. n.; La Concepción, 15 kilometers east of Quibdó, *Archer* 1998, 1970.

Named in honor of Señor Rudolfo Castro, of Quibdó, who was of great assistance to Dr. Archer during his stay in Colombia.

Similar in aspect to *C. album* Morton, with which it grows, but easily distinguishable by its very small yellow corollas. The corolla tube is cylindric and hardly at all widened upwardly. The larger, white corollas of *C. album* have a markedly ampliate corolla tube and very wide throat.

7. Cremosperma nobile Morton, sp. nov.

Herba parva, vix 20 cm. alta; caules crassi, teretes, dense lanati; lamina foliorum ovata, maxima ca. 4.5 cm. longa et 3 cm. lata, plus minusve crassa, apice acuta, basi rotundata, perspicue crenata, supra hirsuta, elongato-tuberculata, subtus hirsuta, nervis secundariis 5–8 jugis; petiolus crassus, usque ad 2 cm. longus, dense lanatus; pedunculus communis crassus, brevis, ca. 12 mm. longus, dense lanatus; flores racemoso-capitati, pedicellis brevissimis, paucis, hirsutis; calycis tubus ca. 3.5 mm. longus, extus hirsutus, intus glaber, lobis lineari-lanceolatis, ca. 5 mm. longis, acuminatis, extus hirsutis; corollae tubus gracilis, ca. 8 mm. longus, anguste cylindricus, ca. 1 mm. latus, sursum gradatum ampliatus, ca. 1.5 mm. latus, glaber, lobis magnis, ca. 6 mm. longis, patentibus, extus pilosis; ovarium cylindricum, glabrum; discus annularis, integer, glaber; fructus deest.

Type in herbarium of the New York Botanical Garden, collected at Armada, Province of Nariño, Colombia, May 22, 1876, by E. André (no. K43).

A peculiar species by reason of the elongate-tuberculate upper surfaces of the leaves, in which respect it is analogous to *Besleria princeps* Hanst.

8. Cremosperma hirsutissimum Benth. Plant. Hartw. 234. 1846.

Founded on a Hartweg specimen collected in the Andes of Popayán, Colombia. This, the type species of the genus, has not since been recollected.

9. Cremosperma album Morton, sp nov.

Herba repens, usque ad. 20 cm. alta; caules teretes, crassi, hirsuti; folia opposita, aequalia, lamina suborbiculari, maxima ca. 9 cm longa et 6.2 cm. lata, membranacea, apice dentata vel subintegra, late rotundata, basi subcordata, supra hirsuta, subtus imprimis in nervis hirsuta, nervis secundariis ca. 5 jugis; petiolus crassus, hirsutus, usque ad 2.2 cm. longus; pedunculus communis usque ad 4 cm. longus, dense hirsutus; flores racemoso-capitati, numerosi, pedicellis brevibus, 1.5–3.5 mm. longis, hirsutis; calyx late turbinatus, ca. 5.5 mm. longus, hirsutus, lobis ovatis, latis; corolla alba, 12–15 mm. longa, pilosa, tubo basi cylindrico, ca. 2 mm. lato, sursum subito ampliato et 8 mm. lato, lobis magnis, ca. 3 mm. longis, patentibus, late rotundatis, ovarium glabrum; discus annularis, altus, irregulariter erosus, glaber.

Type in the herbarium of the Academy of Natural Sciences, Philadelphia, no. 642,503, collected at Córdoba, Dagua Valley, Department of El Valle, Colombia, altitude 80–100 meters, May 8, 1922, by E. P. Killip (no. 5242). Duplicates in the Gray Herbarium, the herbarium of the New York Botanical Garden, and the U. S. National Herbarium. An additional specimen was collected in the Intendencia de Chocó by Triana.

10. Cremosperma cinnabarinum (Fritsch) Morton, comb. nov.

Besleria (Cremosperma) cinnabarina Fritsch, Notizbl. Bot. Gart. Berlin.

11. 976. 1934.

Type collected in glades of dense forests in the Montaña de Caramanta, Dept. of El Valle, Colombia, August, 1891, altitude 2,300–2,600 meters, by F. C. Lehmann (no. 7441).

The present species, of which I have seen no material, may not be congeneric with those above described, the axillary flowers, as well as the corolla color, being anomalous. The habit also is apparently different, the stem being described as up to one meter long, whereas the stems of none of the other species exceed 30 cm. in length. Lehmann's note is as follows: "Weed with fleshy stems up to 1 m. in height. Leaves dull yellow green. Flowers light vermilion."

BOTANY.—*A new species of* Maurandia *from Death Valley.*[1] FREDERICK V. COVILLE and C. V. MORTON, U. S. NATIONAL HERBARIUM.

The genus *Maurandia* of the family Scrophulariaceae consists, according to the monograph[2] by Prof. P. A. Munz of Pomona College, of eight species, all natives of Mexico with the exception of *M. antirrhiniflora* H. & B., a peculiar species which has been shifted back and forth between *Maurandia* and *Antirrhinum* for many years. At the time of publication of this monograph *M. antirrhiniflora* was the only species known from the United States, but shortly thereafter a second species, *M. acerifolia*[3] Pennell, was described from Arizona. During the course of field work in Death Valley under the auspices of the National Geographic Society the senior author in company with Mr. M. French Gilman found a plant of this alliance which at first was considered to represent a new generic type, because of its one-celled ovaries and capsules. Later collections by Mr. Gilman have shown, however, that occasionally both cells of the ovary are fully developed and fertile. It has seemed best, therefore, to consider this plant, despite its peculiar characters, as a new species of *Maurandia*, although future studies may show that it is as distinct generically as *Epixiphium* and *Rhodochiton*, monotypic genera segregated from *Maurandia.*

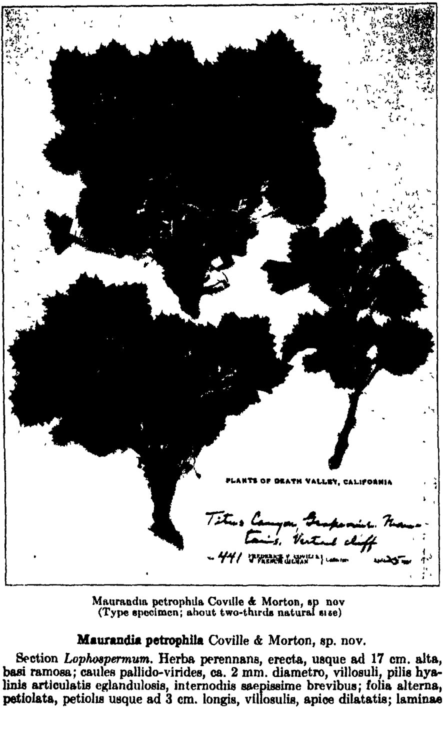
That our knowledge of the flora of the arid Southwest is as yet far from complete is well shown by the fact that the only yellow-flowered species of *Maurandia* known, viz., *M. flaviflora*, *M. acerifolia*, and *M. petrophila*, have all been discovered within the last few years. *M. petrophila* does not resemble the other two very closely.

The original specimens were growing in a crevice of the north-facing, vertical rock wall of Titus Canyon, composed at that point of a almost white limestone.

[1] Published by permission of the Secretary of the Smithsonian Institution Received April 30, 1935.

[2] *The Antirrhinoideae-Antirrhineae of the New World* Proc Calif. Acad. Sci. IV. 15: 323–397. 1926.

[3] This JOURNAL 19: 69 1929



Maurandia petrophila Coville & Morton, sp nov
(Type specimen; about two-thirds natural size)

Maurandia petrophila Coville & Morton, sp. nov.

Section *Lophospermum*. Herba perennans, erecta, usque ad 17 cm. alta, basi ramosa; caules pallido-virides, ca. 2 mm. diametro, villosuli, pilis hyalinis articulatis eglandulosis, internodiis saepissime brevibus; folia alterna, petiolata, petiolis usque ad 3 cm. longis, villosulis, apice dilatatis; laminae

ambitu suborbiculares, usque ad 3 cm. longae et latae, membranaceae, pallido-virides, basi in petiolum attenuatae, apice rotundatae vel acutae, margine irregulariter et acriter spinuloso-dentatae, utrinque molliter villosulae; flores in axillis foliorum solitarii, pedicellati, pedicellis brevissimis; calycis segmenta fere libera, lineari-lanceolata, per anthesin usque ad 15 mm. longa et 2.5 mm. lata, acuminata, margine valde spinulosa, pallido-viridia, utrinque villosula; corolla lutea, tubulosa, usque ad 3.5 cm. longa, basi non saccata, tubo ca. 5 mm. lato, extus fere glabro vel apicem versus villosulo, intus glabro vel pilis paucis hyalinis praedito, sursum gradatim ampliato, fauce 7–9 mm. lato, plicis duobus aurantiacis vix puberulis instructo, lobis patentibus, magnis, usque 9 mm. longis, imbricatis, basi paullulum angustatis, apice late rotundatis, integris; stamina 4, didynama, inclusa, filamentis sparse stipitato-glandulosis, apice recurvatis, antheris semicircularibus, loculis explanatis, discretis, glabris; staminodium nullum; ovarium glabrum, ovoideum; stylus tenuis, glaber; discus hypogynus brevis, annularis; capsula sphaeroidea, ca. 9 mm. diametro, glabra, stylo peristente coronata, unilocularis (loculo altero abortivo, sterili) vel rarissime bilocularis, placenta magna intrusa persistente, irregulariter apice dehiscens, textura membranacea; semina numerosa, subpyramidalia, ca. 2.5 mm. longa, 2 mm. apice lata, pallido-flava vel cinerea, apice alulis brevissimis non nunquam transversalibus praedita, dense tuberculata, tuberculis spongiosis, in lineis irregularibus longitudinalibus dispositis.

Type in the U. S. National Herbarium, no. 1,565,465, collected in Titus Canyon, Grapevine Mountains, Death Valley, California, April 25, 1932, at 2100 feet elevation, by Frederick V. Coville and M. French Gilman (no. 441). Mr. Gilman has since collected this species at the type locality, on April 17 and April 29, 1934 (*Gilman* nos. 1108 and 1195 respectively).

The following key will serve to separate the present species from *M. acerifolia:*

Leaves conspicuously spinulose, suborbicular; pedicels very short; corolla up to 35 mm. long; calyx lobes linear-lanceolate, spinulose; seeds pale, about 2.5 mm. long . . . . **M. petrophila.**

Leaves shallowly dentate or lobed, cordate or reniform; pedicels 10–20 mm. long; corolla up to 22 mm. long; calyx lobes triangular-ovate, entire; seeds gray or blackish, 1–1.5 mm. long **M. acerifolia.**

SCIENTIFIC NOTES AND NEWS

Prepared by Science Service

NOTES

U. S. Department of Agriculture.—A systematic search for the best existing strains of cultivated plants and domestic animals has been undertaken by the Department, in cooperation with the 48 state agricultural experiment stations, genetics research institutions in foreign countries, and private plant and animal breeders. The initial task undertaken is the compiling of a catalog of plant and animal *superior germ plasms*. A committee under the chairmanship of O. E. REED, chief of the Bureau of Dairy Industry, and including Dr. A. F. BLAKESLEE of the Carnegie Institution of Washington, is now assembling and analyzing a mass of data from experiment stations and elsewhere. The results of this analysis will appear in the 1936 Yearbook of the Department of Agriculture. The next step will be to concentrate on those plant and animal problems most capable of solution by genetic improvement, and to work out effective research methods. The final step involves distribution of breeding stocks to the best possible advantage.

U. S. National Park Service.—Late in April Assistant Director HAROLD C. BRYANT made a tour of inspection of the Great Smoky Mountains National Park with a view to laying the ground work for educational activities to be carried on when that area receives full national park status. It is the opinion that trips afield to study plant and animal life will become very popular with visitors because of the wide variety and unique forms to be found there.

Park naturalist ARTHUR STUPKA of Acadia National Park has been detailed to the National Capital Parks Office for a period of six weeks to institute a series of educational programs similar to those given last Spring. A complete series of field trips and campfire programs in Rock Creek Park has been arranged.

National Bureau of Standards.—Dr. LYMAN J. BRIGGS, Director of the National Bureau of Standards, is serving as chairman of the advisory committee of the 1935 stratosphere flight, under the auspices of the National Geographic Society and the U. S. Army Air Corps. Dr. BRIGGS left Washington on May 28, to deliver the baccalaureate address at the South Dakota State School of Mines, Rapid City, S. D., on May 30, before proceeding to the stratocamp in time to supervise the final arrangements for the flight which will take place on the first favorable opportunity after June first.

Dr. F. L. MOHLER of the optics division of the National Bureau of Standards spent the week of May 5 in Rochester, N. Y., for the purpose of inspecting the two spectrographs which will be used in the 1935 stratosphere flight. The National Geographic Society has asked Dr. MOHLER to be present at the stratocamp to make the final adjustments of these instruments.

Dr. W. G. BROMBACHER is at the stratocamp at Rapid City, South Dakota, at the invitation of the National Geographic Society to assist in the installation of the instruments for measuring air pressure and air temperature. The instruments to be installed on the stratosphere balloon include a resistance thermometer, a U-tube type mercurial barometer about 6 inches high and a precision aneroid barometer of unusual design constructed this year. Dr. BROMBACHER will also serve as the directing official for the National Aeronautic Association through which organization certification is

made of the altitude attained in order to obtain international recognition.

Dr. H. C. DICKINSON, chief of the heat and power division, has been appointed to represent the National Bureau of Standards in connection with the organization of a sectional committee under A. S. A. procedure on standards for the inspection of motor vehicles, at the invitation of the American Standards Association of New York City.

U. S. Geological Survey.—The Interior Department through the Geological Survey has released the regular report of monthly and annual production of electricity for public use in the United States for 1934. This report shows for each State the monthly production of electricity for public use by the use of water power and the use of fuel and the amount of coal, oil, and gas consumed in generating electricity. The total production in 1934 was 91,150,000,000 kilowatt-hours, an increase of 6.7 per cent over the output for 1933 which in turn was 2.7 per cent above the total output for 1932. The output for 1934 was 6.4 per cent less than the record output of 97,352,000,000 kilowatt-hours in 1929.

George Washington University and Carnegie Institution of Washington.—A conference on theoretical physics was held in Washington, D. C., on April 19, 20, and 21, under the joint auspices of the Carnegie Institution of Washington and the George Washington University. This was the first of a series which it is hoped may be held annually in Washington. The discussions at this first conference were devoted to various topics in nuclear physics. Researches in this field are being conducted at the Department of Terrestrial Magnetism of the Institution and George Washington University.

In addition to interested men of science from Washington, the following were present: G. BREIT, University of Wisconsin; E. U. CONDON and R. LADENBURG, Princeton University; P. A. M. DIRAC, Princeton and Cambridge universities; S. GOUDSMIT and G. E. UHLENBECK, University of Michigan, A. LANDÉ, Ohio State University; L. NORDHEIM, Purdue University; H. A. BETHE, Cornell University; G. BECK, University of Kansas, I. I. RABI, Columbia University; O. STERN and S. A. YOUNG, Carnegie Institute of Technology; J. H. BARTLETT, University of Illinois; D. R. INGLIS, University of Pittsburgh; E. FEENBURG, Harvard University; W. K. HOUSTON, California Institute of Technology; E. O. LAWRENCE, University of California; LEO SZILARD, Oxford University; L. H. GRAY, Cambridge University.

NEWS BRIEFS

The quick healing of bad wounds brought about by fly larvae introduced into them is at least partly due to the secretion of allantoin by the larvae, Dr. WILLIAM ROBINSON of the Bureau of Entomology, U. S. Department of Agriculture, has discovered. Allantoin has long been used in the treatment of ulcers and infected wounds.

The School of Medicine of George Washington University announces the acceptance of several grants for various research projects as follows: From the Rockefeller Foundation the sum of $25,500 in support of studies in the department of biochemistry; a renewal of the Kane-Kotz Fund of $1,700 for studies on clinical endocrinology in the department of obstetrics and gynecology; from the Eli Lilly Company the sum of $1,200 for a fellowship in biochemistry, and a grant of $1,800 for the study of the post-pituitary hormones from Parke, Davis and Company.

PERSONAL ITEMS

Dr FRANK RATTRAY LILLIE, of the University of Chicago and the Woods Hole Marine Biological Laboratory and Oceanographic Institute, has been elected President of the National Academy of Sciences and Chairman of the National Research Council

Dr ISAIAH BOWMAN, retiring Chairman of the National Research Council, has been elected President of the Johns Hopkins University

Dr VERNON KELLOGG, Secretary Emeritus of the National Research Council, was elected Honorary Vice President of Science Service upon his retirement from the board of trustees of that Institution New trustees elected are Dr HARLOW SHAPLEY, director of Harvard College Observatory, representing the National Academy of Sciences, Dr HENRY B WARD, permanent secretary of the American Association for the Advancement of Science, representing that institution, and Dr LUDVIG HEKTOEN, director of the John McCormick Institution for Infectious Diseases, representing the National Research Council

At the commencement exercises of Washington College, Chestertown, Maryland, the degree of Doctor of Laws was conferred on Dr JOHN M H ROWLAND, dean of the Medical School of the University of Maryland, and on Dr ROBERT L SWAIN, Deputy Commissioner of Food and Drugs of Maryland and past president of the American Pharmaceutical Society

The Walter Rathbone Bacon traveling scholarship of the Smithsonian Institution has been awarded to Dr RICHARD E BLACKWELDER of the U S National Museum, for an intensive study of the staphylinid beetles of the West Indies

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PALEONTOLOGY.—*Annotated list of Pleistocene Mammalia from American Falls, Idaho.*[1] C. Lewis Gazin, U. S. National Museum. (Communicated by J. B. Reeside, Jr.)

Pleistocene vertebrate remains have been encountered at several localities along the course of the Snake River in southern Idaho. In the eastern part of the basin the fossils occur in loose sand and gravel and have been uncovered as a result of placer mining or quarrying for road material. At American Falls the fossils were discovered in a gravel quarry a short distance from the eastern end of the American Falls dam. The deposits in the pit consist of alternate layers or lenses of gravel and sand capped by an argillaceous mud, the bones occurring principally in the gravel and coarser sand.

While in Idaho during the summer seasons of 1929 and 1930, Dr. J. W. Gidley, accompanied by C. P. Singleton, visited American Falls and obtained for the National Museum a collection of vertebrate fossils. In 1934 the locality was investigated by the writer's party and additional material uncovered. The greater part of the collection consists of the remains of relatively large animals; apparently, small, fragile specimens were not readily preserved, hence the list is very incomplete.

The assemblage recognized is clearly Pleistocene and may represent a glacial stage as suggested by the presence of musk-ox remains. As to the portion of the Pleistocene represented no certain evidence is apparent in the known fauna. Dr. O. P. Hay[2] cited forms occurring in these gravels at various localities together with the fauna then recognized as from the Idaho formation in the western part of the basin and the whole was allocated to the Nebraskan stage. This procedure was unwarranted as the faunas may be quite distinct, certainly when comparisons are made with the Hagerman assemblage.

[1] Published by permission of the Secretary, Smithsonian Institution. Received February 12, 1935.

[2] Hay, O. P. Carnegie Inst. Wash. Pub. 322B: 268–269. 1927.

EDENTATA

Megalonyx cf jeffersonii (Desmarest)

Megalonychid remains from American Falls consist essentially of two jaw portions and miscellaneous foot bones Description of this and the mylodont material has been presented in an earlier paper [3] No new information is furnished by the additional material obtained in 1934

Paramylodon harlani? (Owen)

Remains of mylodont sloth are scarcer in the gravel pit than those of *Megalonyx* and, since the sloth material collected by Gidley was described, a fourth metacarpal and an ungual claw have been added to the collection

CARNIVORA

Cf **Aenocyon dirus** (Leidy)

The distal portions of two humeri and an abraded phalange cannot be distinguished from the corresponding parts of the large dog *Aenocyon dirus* as represented at Rancho La Brea

Canis sp

An incomplete humerus, a tibia and a third metatarsal are recognized as belonging to a dog somewhat smaller than *Canis occidentalis* but larger than a coyote

Urocyon? sp

A small fox is indicated in the fauna by a fragmentary mandible portion The specimen is without teeth but exhibits the alveoli for the posterior root of the carnassial, M_2 and the single rooted M_3

Ursid sp

The proximal end of a large femur and a fragmentary distal end of a humerus included in the collection are recognized as bear The specimens suggest an individual about the size of the Alaskan brown bear, *Ursus gyas*, although the form represented may well be one of the large arctotheres The fragment of a humerus is not sufficiently complete to show the presence or absence of an entepicondylar foramen

Felis near **F atrox** Leidy

Representing the cat is a fourth metacarpal, no 13723 U S N M , and a radius, no 13747 U S N M The total length of the fourth metacarpal is 114 mm , this being smaller than the average in *Felis atrox* of Rancho La Brea but somewhat greater than the minimum figure given by Merriam and Stock [4] However, the fourth metacarpal appears relatively slenderer than

[3] GAZIN, C L. Jour Mammalogy 16 52-60 1935
[4] MERRIAM, J C and STOCK, CHESTER. Carnegie Inst. Wash. Pub 422 131-133, table 60, fig. 96. 1932.

the Rancho La Brea specimen figured. The radius is 312 mm. long, which is 5 mm. under the least figure given by Merriam and Stock for this element. The radius is comparable in size to radii in large individuals of *Felis leo*. It is possible that an unusually large individual of *Felis daggetti* is represented.

RODENTIA

Citellus sp.

In the scant collection of rodents from American Falls are five fragmentary mandibles of ground squirrel. In only one of the jaws are any teeth preserved and these are so badly worn that the cusp pattern is entirely obliterated. The specimens represent a small species apparently close in size to *Citellus richardsonii*. A resemblance is also seen to *Citellus elegans*, although the fossil jaws differ somewhat from both modern forms in having a relatively longer cheek tooth row, as indicated by the alveoli.

Thomomys cf. townsendii (Bachman)

Pocket gophers are represented by eight mandible portions and a number of limb elements. Four of the jaws retain P_4 and in one the second molar is preserved. The species is distinctly large and compares favorably with *Thomomys townsendii*, now living in the vicinity of American Falls. Comparison, however, with several specimens of *T. townsendii* show the teeth in the fossil jaws to be somewhat wider than the average in living specimens

Castor sp.

The beaver material includes the greater part of a tibia, the distal end of a femur and two metapodial fragments. These indicate a beaver somewhat larger than *Castor canadensis*, approaching in size the later Pliocene beaver found at Hagerman. Possibly the species *Castor accessor* Hay is represented although no teeth were found on which to make a comparison

Erethizon sp.

A single left ramus of a mandible without cheek teeth and retaining only the base of an incisor is recognized as porcupine.

LAGOMORPHA

Lepus sp.

A relatively large hare is indicated by several fragments of tibiae and femora, the distal end of a humerus, two calcanea, two metapodials and phalanges. The form represented may be *Lepus townsendii* or *Lepus californicus*. From the age of the deposits it is unlikely that *Hypolagus* is included.

Sylvilagus? sp.

A fragment of a lower jaw without teeth, and a few fragments of limb bones show the presence of a second and distinctly smaller leporid. The jaw

is about the size of that in the brush rabbit, *Sylvilagus bachmani*. Although the form represented may be a species of *Brachylagus*, the living *Brachylagus idahoensis* possesses a somewhat smaller jaw.

PROBOSCIDEA

Mammut americanum (Kerr)

Included in the mastodon material is a right mandibular ramus, No. 13701 U. S. N. M., in which is preserved a moderately worn last molar. The specimen corresponds closely to other specimens in the National Museum identified as this species.

Elephas columbi? Falconer

Two maxillary portions in the collection, one of which No. 13703 U. S. N. M., retains a partially worn last molar and the other, No. 13702 U. S. N. M., a badly worn second molar in addition to the third, are apparently to be referred to the columbian mammoth

PERISSODACTYLA

Equus cf. occidentalis Leidy

Horse remains consist of an assortment of teeth and foot bones. The teeth are appreciably smaller than in *Equus pacificus* as represented at Christmas and Fossil Lakes in Oregon, and somewhat smaller than the type of *Equus idahoensis*. The specimens do not differ greatly in size from *Equus occidentalis* material from Rancho La Brea but the enamel pattern is slightly more complicated, comparable in this respect to the type of *E. occidentalis* as illustrated by Leidy.[5] The pattern on the teeth varies considerably between specimens but is distinctly simpler than in most teeth described as *Equus complicatus*

ARTIODACTYLA

Camelops cf. hesternus (Leidy)

Perhaps the most abundant material obtained from the gravel deposit is that of camel. This includes considerable limb and foot material and an assortment of upper and lower teeth. There are also a maxillary portion of the skull with three molars, No. 13718 U. S. N. M., a premaxillary-maxillary fragment, No. 13719 U. S. N. M., with the third incisor and alveolus for the canine, and three incomplete mandibles. One of the lower jaws, No.13720 U. S. N. M., possesses a complete, though well worn, cheek dentition. The form is apparently close to *Camelops hesternus* as identified at Rancho La Brea, and probably identical to *Camelops minidokae* Hay[6] from a gravel bed

[5] LEIDY, JOSEPH. U. S Geol. Surv. Terr Rept., 1: pl. 33, figs. 1-2. 1873.
[6] HAY, O. P. Op. cit., 90-93, pl. 8, figs. 2-3. 1927

near Minidoka, Idaho. The American Falls jaws do not show evidence of a vestigal P_3 seen in the type of *C. minidokae* but this character may not have been persistent in the Minidoka camel as the teeth are otherwise similar to those in the American Falls form. Comparisons between the premaxillary-maxillary portion and the type of *Camelops kansanus* as illustrated by Merriam[7] show the alveoli for I^3 and C to be somewhat larger but less widely separated in the American Falls specimen. However, no important differences in teeth and foot material were observed when comparisons were made with *Camelops kansanus* from Hay Springs, Nebraska.

Cf. **Antilocapra americana** (Ord)

Two humeri, a tibia, calcaneum and an incomplete anterior cannon bone in the collection are nearly identical with those in the living prong-horn antelope. It is interesting to note that these elements with the possible exception of the cannon bone can be closely approximated in the mule deer, *Odocoileus hemionus* and in the columbian black-tailed deer, *Odocoileus columbianus*.

Bison alleni Marsh

Nearly all of the bison material in the collection, which is almost as abundant as camel, is referred to *Bison alleni*. A cranial portion, No. 13692 U.S. N. M., including the right horn-core and a somewhat larger isolated horn-core, No 13693 U. S. N. M., are so close to the type of *B alleni* that the identity is not questioned. In addition to the horn material are portions of seven jaws, a number of loose teeth and a variety of limb and foot bones The size of the limb and foot bones in addition to the heaviness of the horns indicate an animal of considerable robustness.

Bison sp.

An isolated bovid cannon bone, No. 13713 U. S N. M , in the collection is considerably smaller than those referred to *Bison alleni* and compares favorably with the corresponding element in a small individual of *Bison occidentalis* as recognized in a Pleistocene collection from Riverton, Minnesota.[8]

Symbos cavifrons (Leidy)

The collection includes two incomplete musk-ox skulls, a portion of a palate with two molars on each side, a fragment of a lower jaw and a few isolated teeth The two skulls exhibit both horn-cores and the occipital region, but the rostral portion is missing in one and only partially preserved in the other. The skulls are characterized by unusually robust horns, the extremities of which extend well out from the skull. It may be noted that in much of the described skull material referred to *Symbos cavifrons* the horns are less robust and more rapidly tapering than in the type as illustrated by

[7] MERRIAM, J. C. Univ. Calif. Pub. Bull. Dept. Geol. 7: 305–323, figs 10a–10b. 1913.
[8] HAY, O. P. Proc. U. S. Nat. Mus. 63: art. 5. 1–8, pls. 1–2. 1923.

Osgood,[9] whereas the American Falls specimens have even heavier and longer horns which stand out from the side of the skull somewhat more than in the type. It is estimated that the distance between the extremities of the horn-cores on one of the specimens, though the tips are not complete, would be about 680 mm. The anteroposterior diameter at the base of the horn is about 115 mm. and the vertical diameter about 102 mm.

[9] OSGOOD, W. H., Smithsonian Misc. Coll., Quart. Issue, 3: pt 2, 173–185, pl. 40, fig 1, pl. 41, fig. 1. 1905.

BIOLOGY.—*Longevity and fertility in the pond snail*, Lymnaea columella.[1] CHARLES P. WINSOR AND AGNES A. WINSOR. (Communicated by RAYMOND PEARL.)

The essential preliminary to any reasoned, quantitative discussion of population problems is accurate knowledge of birth and death rates. Unfortunately, such knowledge is almost completely non-existent. Aside from our knowledge about man, virtually everything that we know of birth and death rates in other forms is due, directly or indirectly, to Pearl. Under these circumstances it seems legitimate to add a certain amount of data, even though it fails to conform in all respects to the standards set by Pearl on *Drosophila.*

The data here presented deal with duration of life and fertility in the pulmonate gastropod *Lymnaea columella.* Some account of the biology and laboratory husbandry of this animal has already been given by Baily (1) and by ourselves (7).

The conditions under which the observations were made may be stated briefly. Eggs from wild snails isolated in the laboratory were collected and separated before hatching; from each egg mass 10 eggs were placed in one finger bowl and 2 eggs in each of five others. A total of 180 snails was used in each series. Leaf lettuce was used as food, except for a period of about four weeks during which iceberg lettuce was used. The substitution was unavoidable, and unfortunate. Lettuce and water were changed three times a week; the conditions were arranged so that light and temperature were reasonably uniform or all animals.

The wild parents of the snails were collected in two ponds in the vicinity of Baltimore, designated here as the Falls Road pond and the Boyce Avenue pond. In addition to these wild ancestors of known origin, two snails isolated from laboratory aquaria furnished eggs for

[1] From The Department of Biology of The School of Hygiene and Public Health, The Johns Hopkins University, and The Biological Laboratories, Harvard University Received March 14, 1935.

this experiment; nothing is known concerning their origin. These animals were isolated in the laboratory in finger bowls with about 150 ml. of spring water, fed with leaf lettuce, and their eggs collected

TABLE 1.—PERCENT SNAILS SURVIVING AT GIVEN AGES (RECKONED FROM OVIPOSITION)

Age in Days	Percent Surviving Initial Density 2	Percent Surviving Initial Density 10
15	100.0	100 0
25	91 6	76.4
35	79 9	62 4
45	77.1	47 9
55	76 0	47 3
65	74.9	45.5
75	74 3	45.5
85	74 3	45 5
95	70.4	43.7
105	70.4	42 5
115	68 2	38.8
125	67.0	37 6
135	64 3	34 6
145	60 9	34 0
155	50 3	31 0
165	41.9	25 5
175	30.7	22 5
185	18.4	10 9
195	4.5	4 8
205	2 2	0 6
215	1 1	0 0
225	0 0	

daily. The eggs so obtained were allowed to develop for about a week, at which time healthy-appearing clutches were selected for the experimental population. These eggs were removed from the capsule and placed in finger bowls with spring water.

TABLE 2.—BIOMETRIC CONSTANTS OF DURATION OF LIFE

	Initial Density 2	Initial Density 10
Mean	128.8 ± 3 2 days	88.7 ± 3 6 days
Standard Deviation	63 4 ± 2 3 days	70 2 ± 2 5 days
Coefficient of Variation	49.2 ± 2 1%	79 1 ± 5 3%

Table 1 and Figure 1 show the survivors at given ages out of 100 snails hatching. Table 2 gives the mean, standard deviation, and coefficient of variation of duration of life for each series.

It will be observed that these life tables differ from those hitherto published for *Drosophila* and other forms, in that there is present a

high infant mortality. We do not feel entirely certain, however, that this mortality is not at least partially attributable to experimental technique. Of the total deaths under forty days, just over half, in each series, were due to snails crawling out of water and drying on the dish (45

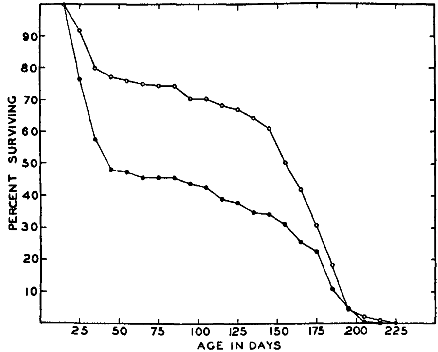

Fig. 1.—Percent snails surviving to given ages. Open circles density 2, solid circles density 10.

out of 85 deaths in the 10 snail series, 22 out of 40 in the 2 snail series). But we may observe that (a) this mortality is markedly higher in the high density series, and (b) there remains a high infant mortality even after deaths from desiccation have been excluded. Whether improved technique would eliminate infant mortality is not certain, though we are disposed to believe that it would.

We may further note that except for infant mortality there are no significant differences in the life tables at the two densities.

In Table 3 are presented data relative to egg production. In this table we have indicated the parentage of the snails considered, and for each parent we have grouped the data according to the density at the date of deposition of the first eggs. We have calculated in each case

the egg production per snail at each density, and also the egg production per snail-day in excess of 70 days. (The figure of 70 days corresponds approximately to the date of earliest egg production; no es-

TABLE 3.—EGG PRODUCTION

Parent	Density	Number of Cases	Total Eggs	Eggs per Snail	Total Snail-days over 70	Eggs per Snail-day
1	3	1	658	219	260	2 53
	2	2	1,298	325	276	4 70
	1	2	1,604	802	189	8.48
2	7	1	1,283	183	664	1 94
	6	1	1,116	186	577	1 94
	5	1	1,729	346	422	4 09
	2	10	18,542	927	1,573	11 15
	1	4	3,907	977	308	12.66
4	5	2	7,316	732	813	9 00
	3	1	594	198	147	4 04
	2	9	22,489	1,249	1,748	12 86
	1	4	7,360	1,840	430	17 12
8	4	1	1,404	351	326	4 31
	2	7	4,941	353	1,076	4 59
	1	4	3,512	878	408	8 61
12	4	1	1,731	433	405	4 27
	2	8	9,729	608	1,571	6.19
	1	3	3,048	1,016	316	8.81
15	5	1	3,404	681	530	6 42
	2	4	6,192	774	856	7 23
	1	1	51	51	57	.90
16	8	1	2,427	303	588	4 13
	4	1	2,724	681	481	5 66
	2	8	11,090	693	1,737	6 38
	1	2	1,431	715	188	7 61
17	3	1	1,972	657	339	5 82
	2	3	4,609	768	660	6 98
	1	1	778	778	123	6 33
A-2	3	1	2,367	789	241	9 82
	2	1	2,640	1,320	222	11 89
	1	5	8,404	1,681	541	15 53
A-3	3	1	4,398	1,466	358	12.28
	2	3	5,948	991	530	11.22
	1	2	3,023	1,511	206	14 67

sential change is introduced if we use some other figure, as 60 days, or even if we use total snail days.)

There are two features of this table which deserve comment. First, considerable differences in fertility exist from one strain to another, which suggest genetic differences. Second, and more important, there

is a clearly marked effect of density of population on fertility. With very few exceptions, there is a regular increase in fertility per head, however measured, as density decreases. (The exceptions may reasonably be attributed to sampling fluctuations.) We thus see that in these animals the same effect of density on fertility exists which Pearl (5) has found in *Drosophila*. Whether the mechanism of the effect is similar cannot at present be stated.

A third point which seems to us of some interest relates to the reproductive physiology of these animals. As we have already shown, isolated animals lay more eggs than pairs. Further, observation indicates that the proportion of viable eggs is as high in the eggs laid by singles as in those laid by paired animals. On the other hand, Boycott and Diver (2), who, in the course of their genetic work have raised enormous numbers of *Lymnaea*, state that cross-fertilization is apparently the rule; and that isolated animals will reproduce, but apparently only as a last resort, their egg production beginning markedly later than that of pairs.

TABLE 4.—Age in Days at First Oviposition, Pairs and Singles

Pairs			Singles	
Wild Parent	Number of Dishes	Mean Age at First Oviposition	Number of Dishes	Mean Age at First Oviposition
1	2	91 0	2	122 0
2	10	77.7	4	75 0
4	9	78.4	4	77 0
8	6	95.3	4	87 3
12	7	82.9	3	78.7
15	4	85 7	1	94 0
16	7	93 1	2	82 5
17	3	91 3	1	92 0
A-2	1	81 0	5	72.8
A-3	3	76.3	2	76 5
General Mean		86 2		82.3

We have examined our records and present in Table 4 data showing the mean age at first oviposition of singles and pairs. We have grouped the animals by parentage, because there seem to be considerable differences among strains as to age of reaching maturity. The numbers are not large, and the results not too consistent; but we think it is clear that singles lay at least as early as pairs. Whether this difference between our results and those of Boycott represents a difference in the physiology of the species, or a difference in experimental conditions, we cannot say.

The interest of the observation, we may remark, lies in the problem

it suggests. We know that the animals are hermaphroditic and capable of self fertilization; but we also know, from Boycott's work and from that of Piaget (6), that cross-fertilization takes place if opportunity is offered. The anatomy of the animals, as Crabb (3, 4) has shown, would appear to make cross-fertilization extremely improbable, unless some physiological mechanism not apparent anatomically actively favors foreign sperm. What the nature of this mechanism may be seems a problem worth the attention of some qualified worker.

SUMMARY

(1) Life tables for *Lymnaea columella* are presented for two different initial densities, 2 and 10 snails per dish.

(2) Data on egg production show differences in fertility between strains, and show marked reduction in fertility with increasing density of population.

(3) No significant differences exist in the date of first oviposition as between isolated and paired animals.

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BOTANY.—*Three new plants from Death Valley, California.*[1] C. V. MORTON, National Museum. (Communicated by FREDERICK V. COVILLE.)

The following three new species are from the collections made in Death Valley in 1931 and 1932 by Dr. Frederick V. Coville and associates, under the sponsorship of the National Geographic Society.

Ephedra funerea Coville & Morton, sp. nov.

Frutex pallidus, dioicus, erectus, usque ad 1 3 m. altus, ramosissimus; ramuli teretes, ca. 3 mm. crassi, striati, asperi, glandulosi, apice pungentes;

[1] Published by permission of the Secretary of the Smithsonian Institution. Received March 25, 1935.

folia terna, ad vaginas reducta, ca. 5 mm. longa; spiculae ♀ uniflorae vel interdum biflorae, sessiles, solitariae vel geminae, ambitu ellipticae, ca. 10 mm. longae; bracteae unguiculatae, margine leviter crenulatae, maturae plus minus erectae, dorso vix incrassatae, pallido-virides, alis scariosis, lutescentibus, basi cuneatis; fructus viridis, vix exsertus, elongato-pyramidatus, apice acuminatus, laevis, nec scaber nec papillosus; tubillus rectus exsertus; semina matura desunt.

Type in the U. S. National Herbarium, no. 1,565,472, collected at Furnace Creek Canyon, on the Ryan-Shoshone road, Death Valley, Inyo County, California, altitude about 1,000 meters, April 26, 1932, by Frederick V. Coville and M. French Gilman (no. 447).

Additional specimens examined, all from Death Valley are as follows:

CALIFORNIA: Furnace Creek Canyon, near the old town of Ryan, April 25, 1932 (*Coville & Gilman* 444, 445, 446); Furnace Creek Canyon, Junction of the Dantes View road with the Ryan-Shoshone road, April 26, 1932 (*Coville & Gilman* 448); Warm Springs Canyon, Panamint Mountains, about a mile above Warm Springs, April 30, 1932 (*Coville & Gilman* 502, 502a); Boundary Canyon, alt. about 1,050 meters, April 24, 1932 (*Coville & Gilman* 407, 408, 409, 410); Furnace Creek Canyon, alt. about 770 meters, April 16, 1931 (*Coville & Gilman* 19); Furnace Creek Canyon, alt. about 950 meters, April 18, 1931 (*Coville & Gilman* 108, six specimens, all from different plants); Dantes View, alt. about 1,800 meters, April 18, 1931 (*Coville & Gilman* 95); pass above Ryan, on road between Furnace Creek Ranch and Shoshone, June 11, 1930 (*Thackery, Gilman, & Peebles* 284c); slope of Salsberry Pass, Funeral Mountains (*Charles Brown*); one mile south of Ryan, *C. L. Hitchcock* 12329 (Herbarium University of California); two miles east of Bradbury Well, *J. T. Howell* 3643 (Herbarium California Academy of Sciences).

The present species is most nearly related to *Ephedra californica* S. Wats., which has not been found in the Death Valley region In *E. californica* the fruits are broadly elliptical with rounded apices, in contrast to the elongate, acuminate fruits of *E. funerea*. The fruiting scales of *E. californica* are fleshier, more closely appressed, shorter-clawed, and usually borne in more numerous series. *Ephedra funerea* differs somewhat in habit also, being very spinose, intricately branched, and very pale green

Ephedra torreyana S. Wats., not as yet found in California, may be easily distinguished by its more spreading, scarious bracts and its minutely scabrous fruits.

Eriogonum panamintense Morton, sp. nov.

Subg. *Oregonium*, Sect. *Racemosa;* herba perennis, 20–30 cm. alta, erecta, stricta; rami e basi numerosi, dichotome vel trichotome ramosi, ramulis paucis, rigidis, ca. 1.5 mm. crassis, floccoso-tomentosis; folia radicalia longe petiolata, petiolis usque ad 2 cm. longis, supra paullulum canaliculatis, dense albido-tomentosis, laminis ellipticis, ovatis vel obovatis, 16–25 mm. longis, 10–16 mm. latis, apice rotundatis vel subacutis, basi cuneatis, utrinque dense floccoso-tomentosis; folia caulina orbicularia, ad nodos verticillata,

petiolis brevibus; involucra solitaria, sessilia, pauca, 3–5 mm. longa, extus albido-tomentosa, intus glabra, obtuse angulata, apice 5-dentata, dentibus ca. 1 mm. longis, acutis, margine incurvis; pedicelli numerosi, ca. 7 mm. longi, glabri, basi bracteati, bracteis setaceis, ca. 4 mm. longis, barbulatis, ex involucro haud exsertis; perianthium campanulatum, ca 5 mm. longum, segmentis omnibus oblanceolatis, usque ad 1.5 mm. latis, albis (nervo medio purpureo excepto), glabris, integris, apice rotundatis, basi cuneatis; stamina 9, filamentis basi barbatis, sursum scabridulis, haud exsertis, antheris purpureis; ovarium scabridulum, album, trigonum; fructus deest.

Type in the U. S. National Herbarium, nos. 1,565,892–4, collected at Wild Rose Summit in the watershed of Hanaupah Canyon, Panamint Mountains, Inyo County, California, altitude about 2,600 meters, September 15, 1931, by Frederick V. Coville and Arthur F. Gilman (no. 6).

The present species is most closely related to *Eriogonum wrightii* Torr., but differs from all forms of that species (some of them probably deserving of subspecific rank at least) in numerous characters, as summarized in the following key:

Plants not suffrutescent at base or densely caespitose; basal leaves few, comparatively large and long-petiolate, mostly rounded at apex, not at all revolute, without fascicles of small leaves in the axils; stem leaves restricted to nodes of the inflorescence, verticillate, rotund and short-petiolate, obtuse; involucre 3–5 mm. long; perianth 5 mm. long, the segments oblanceolate. ....**E. panamintense.**

Plants suffrutescent and much branched at base or densely caespitose; leaves many, distributed along the stem, smaller and shorter-petiolate, usually somewhat revolute, all acute, with numerous fascicles of small leaves in the axils; involucre up to 3 mm. long, usually less; perianth usually 3 mm. long or less, rarely up to 4 mm. long, the segments obovate.. .. . . . . **E. wrightii.**

Cymopterus (Aulospermum) **gilmani** Morton, sp. nov.

Herba 12–23 cm. alta, basi fibrosa; caulis foliosus brevis, 3–7 cm. longus, glaber, internodiis brevibus; lamina foliorum pinnata vel subdigitata, trifoliolata, ambitu orbicularis vel late elliptica, ca. 5 cm. longa et lata, pallida et glaucescens, glabra, nervis prominentibus, petiolis elongatis quam foliis duplo vel triplo longioribus, glabris, perspicue striatis, basi dilatatis, purpurascentibus, marginibus scariosis caules amplectentibus; foliolae laterales sessiles, ad medium vel fere ad basin bipartitae, ambitu late flabellatae, maximae 4 cm. longae et 5 cm. latae, segmentis secundariis bipartitis, segmentis tertiariis inaequaliter 2- vel 3-dentatis, segmentis ultimis deltoideis vel triangularibus, acuminatis, integris, maxime 10 mm. longis et basi 7 mm. latis; foliola terminalis similis sed saepe petiolulata et basi decurrens; folia caulina similia sed minora; pedunculus elongatus, fructu 8–18 cm. longus, folia superans, glaber, sulcatus; umbellae compositae; involucri bracteae nullae; radii ca. 8, floriferi usque ad 1 cm. longi, valde inaequales, fructu 1–1.5 cm. longi; involucellorum bracteae ca. 8, lineari-subulatae, ca. 3.5 mm. longae, basi ca. 0.8 mm. latae, apice incurvae, virides, haud scariosae, haud connatae, fructu ampliatae, ca. 5 mm. longae et basi 1 mm.

latae, nervis medialibus prominentibus; umbellulae ca. 15-florae, floribus centralibus 4 vel 5, valde immaturis, fere sessilibus (sterilibus?); pedicelli 1.5–2 mm. longi, ca. 0.5 mm. lati, glabri, striati, erecti, fructu non elongati; sepala conspicua, deltoidea, acuta, viridia vel purpurascentia, ca. 0.3 mm. longa; petala alba vel alabastro purpurascentia, oblanceolata, apice valde et longe acuminata, incurva, ca. 2.3 mm. longa (apice ca. 0.8 mm. longo), ca. 0.8 mm. lata, nervis medialibus prominentibus; filamenta longa, alba, incurva, antheris purpureis; ovarium glabrum, ca. 1 mm. longum, disco prominente, undulato; stylopodium nullum; fructus late ellipticus, ca. 7 mm. latus et 8 mm. longus, dorso valde compressus, apice emarginatus, albus, glaber, alis lateralibus perspicuis, magnis, linearibus, basi leviter angustatis vel dilatatis, ca. 2.5 mm. longis, 0.6 mm. latis, textura spongiosissimis, alis dorsalibus 1 vel 2, similibus, plus minusve reductis, alis vel jugis intermediis nullis; vittae valleculares ca. 7 (in fructu 3-alato) vel 4 (in fructu 4-alato), commissurales ca. 10, conspicuae, lineares, vittis basi alarum nullis; semen facie planum, dorso leviter carinatum.

Type in the U. S. National Herbarium, no. 1,565,689, collected on cliffs along a north fork of Echo Canyon, Funeral Mountains, California, altitude about 1,200 meters, April 19, 1931, by Frederick V. Coville and M. French Gilman (no. 116).

A flowering specimen also has been collected, viz: Slope of Grapevine Mountains, north of Leadfield, Titus Canyon, Death Valley, California, altitude about 1,500 meters, April 25, 1932, by Coville and Gilman (no. 433). An additional fruiting specimen was collected in Titus Canyon, Death Valley, May 8, 1934, by M. French Gilman (no. 1197).

Miss Mildred Mathias on a visit to Washington some time ago kindly looked at the present plant (already determined as an undescribed species but of doubtful affinity), and suggested a relationship with *Aulospermum basalticum* (Jones) Tidestrom (*Cymopterus basalticus* Jones). That species is known only from the type collection, which has been made available for study through the courtesy of Prof. P. A. Munz, of Pomona College. A careful comparison of the two indicates that they are somewhat closely related, at least superficially. The tabulation which follows gives some of the more important distinguishing characters.

In Miss Mathias' recent monograph of the genus *Cymopterus*,[2] *Aulospermum* and numerous other segregate genera are retained, following Coulter and Rose's "Monograph of North American Umbelliferae." The genus *Aulospermum*, in habit quite similar to *Cymopterus*, is distinguished technically by having the seed face concave and the wing bases broadened at the base. In the present species the seed face is plane and the wing bases are either narrowed or broadened at the base, characters which approach closely to *Cymopterus*, although the more obvious relationship of the plant is with *Aulospermum basalticum* and its relatives. It seems necessary, therefore, to unite *Aulospermum* with *Cymopterus*, a conclusion with which Miss Mathias, after having studied the specimens of *C. gilmani*, is now in agreement.

[2] *A monograph of* Cymopterus, *including a critical study of related genera* Ann Mo. Bot Gard. 17: 213–476. 1930.

Terminal leaflet usually narrowed to a petiolule, the leaves therefore pinnate, with the leaflets deeply divided; ultimate segments few, large, up to 10 mm. long and 7 mm. wide at base; bractlets of the involucel linear-subulate, at flowering time about 3.5 mm long and 0.8 mm. wide at base, acuminate, distinct at base, not scarious-margined; fertile flowers all pedicellate; anthers purple; fruit about 7 mm. wide, 8 mm. long, the carpels 1- or 2-winged dorsally, the wings broad, white, very spongy (cellular structure similar to that of elder pith), either narrowed or broadened at base in cross section; oil tubes (in the 3-winged carpels) about 7 in the intervals, or (in the 4-winged carpels) 4, none in wing base, about 10 on the commissure. (Funeral Mountains, California). . . ..**C. gilmani.**

Terminal leaflet scarcely if at all petiolulate, the leaves therefore more nearly digitate than pinnate, with the leaflets less deeply divided; ultimate segments more numerous, very much smaller, the largest about 3 mm. long and 3 mm. wide at base; bractlets of the involucel ovate, acute, about 3 mm. long, 1.5 wide, connate at base, scarious-margined, or sometimes subrectangular, irregularly connate, truncate, erose and mucronate at summit; fertile flowers sessile; anthers yellow; fruit (not quite mature) 5 mm. wide and long, the lateral wings relatively narrow, obviously broadened at base, purplish, the dorsal wing solitary, somewhat reduced; oil tubes 5 or 6 in the intervals, 1 in the wing base, and about 8 on the commissure (Wa-Wa, Utah). **C. basalticus.**

BOTANY.—*New Asteraceae from the United States, Mexico, and South America.*[1] S. F. BLAKE, Bureau of Plant Industry.

The new Asteraceae described in this paper have been found in the course of work on material in the United States National Herbarium and on collections sent to that herbarium for identification.

Chaetospira Blake, nom. nov

Spirochaeta Turcz. Bull. Soc. Nat Mosc. **24** (1). 166. 1851. Not *Spirochaeta* Ehrenb. Abh. Akad. Wiss. Berlin **1833**: 313. 1834.[2]

Chaetospira funckii (Turcz.) Blake.

Spirochaeta funckii Turcz. Bull. Soc. Nat. Mosc. **24** (1). 166. 1851.

The monotypic genus *Spirochaeta* Turcz , united with *Elephantopus* by

[1] Received May 29, 1935.

[2] The volume of the Abhandlungen for 1833 in which Ehrenberg's article appears (there entitled *Dritter Beitrag zur Erkenntniss grosser Organisation in der Richtung des kleinsten Raumes*) is dated 1835 on the title page, but the article itself bears the prefatory note. "Gelesen in der Akademie der Wissenschaften am 2. Juli 1832, revidirt und mit einigen Zusätzen gedruckt im Mai 1834."

most authors but again separated by C. F. Baker[3] in his revision of the group in 1902, seems sufficiently distinct in pappus character to merit recognition. The existence of the same name of an earlier date, in current use for an important genus of Bacteria, makes it necessary to rename Turczaninow's genus. In Bentham & Hooker's Genera Plantarum it was wrongly considered specifically identical with *Pseudelephantopus spicatus* (Juss.) Rohr (*Elephantopus spicatus* Juss., *Distreptus spicatus* Cass.).

Chionolaena columbiana Blake, sp. nov.

Fruticulus paucicaulis ca. 22 cm. altus dense foliosus undique compacte et canescenter subsericeo-tomentosus aetate fuscescens, bracteis glomerulam involucrantibus flavescenti-tomentosis; folia uniformia linearia acutiuscula, lamina patente vel demum reflexa ca. 12 mm. longa 2 mm. lata, petiolo cauli arcte appresso scarioso intus glabro laminam aequante; capitula parva ca. 26-flora apice caulis dense glomerata, glomerulam ca. 12 mm. crassam effingentia; fl. fem. ca. 12, hermaph. ca. 14; achenia glabra.

Stems about 3, ascending or erectish, simple or with a single branch above, about 3 mm. thick below; internodes about 1–3 mm. long, the leaves alternate, multifariously crowded; petioles entirely concealed beneath the wool of the stem, linear-oblong, slightly widened above, 1–1.2 cm. long, 2 mm. wide, 3–4-nerved inside, densely tomentose outside; blades linear or slightly linear-spatulate, 1–1.2 cm. long, 1.5–2.5 mm. wide, bluntly callous-pointed, flattish, closely subsericeous-tomentose on both sides especially beneath, 1-nerved, the nerve somewhat impressed above, concealed by the wool beneath; leaves involucrating the glomerule yellowish-tomentose, about equaling the glomerule, of the same shape as the stem leaves; heads campanulate, 4.5 mm. high, 3 mm. thick (when moistened), densely whitish-lanate at extreme base; involucre 4–4.5 mm. high, about 4-seriate, slightly graduate, the phyllaries erect, linear or lance-linear, 0.5–1 mm. wide, obtuse or acutish, entire or slightly erose at apex, pale straw-yellowish, hyaline throughout, the outermost thinly pilose on back and with dull greenish costa extending about half their length, the others glabrous and veinless; pistillate corollas filiform, whitish, 2.5–2.8 mm. long, unequally 3–4-denticulate, ciliolate around apex; achenes (pistillate flowers) linear-oblong, 0.8 mm. long, glabrous, the pappus bristles 18–19, 2.8 mm. long, slender, minutely serrulate, united at extreme base, falling off in groups; hermaphrodite flowers fertile? (the embryo apparently normally developed), their corollas subcylindric, contracted toward middle, 3 mm. long, whitish, brownish on teeth (tube 0.7 mm., throat 1.7 mm., teeth narrow-triangular, 0.6–0.7 mm. long); achenes linear-oblong, 0.5–0.7 mm. long, glabrous, the pappus bristles 22–26, 2.8–3 mm. long, slender, slightly broadened and bluntly serrulate toward apex, united at base and often irregularly united in groups of 2 or 3 for half or nearly their full length, falling off in groups; style branches very short (0.3–0.4 mm. long), oblong, erect, rounded, papillose on back and margin, without obvious stigmatic lines.

COLOMBIA: Páramos of the Sierra Nevada de Santa Marta, about 30 miles inland from Dibulla, Dept. Magdalena, alt. about 4390 m., July 1932, *William Seifriz* 494 (type no. 1,572,394, U. S. Nat. Herb.).

I have described this species under *Chionolaena* with some hesitation. All

[3] Trans. Acad. St. Louis 12: 53. 1902.

true members of the genus hitherto known are Brazilian; the two Mexican and Central American species referred to it by Hemsley, following Bentham and Hooker, are now by general agreement placed in *Gnaphalium*. The characters and relationships of several of the smaller genera of this alliance require fresh investigation based on a full representation of the described species.

Ichthyothere grandifolia Blake, sp. nov.

Herba elata; caulis dense patenterque pilosus pilis brunneis; folia magna ovata v. ovali-ovata petiolata penninervia acuminata base longe cuneata membranacea minute calloso-denticulata utrinque pilosa; capitula numerosa apice caulis cymoso-paniculata pedicellata; phyllaria exteriora minuta dense ciliata, interiora glabra.

"Coarse herb," 2 m. high; stem stout, 6 mm. thick and more, multistriatulate, its hairs many-celled, 2 mm. long; leaves opposite; naked portion of petiole pubescent like the stem, 1.5–2 cm. long; blades of larger leaves ovate or oval-ovate, 22–28 cm. long, 9–12 cm. wide, rather shortly acuminate and somewhat falcate, minutely callous-denticulate (teeth about 0.5 mm. high, 5–15 mm. apart), featherveined (larger veins 3–4-pairs, below middle of leaf), above deep green, on surface evenly and rather densely pilose with many-celled hairs (slightly thickened at base), more densely so on costa, beneath not paler (when young very densely brown-pilose), similarly pilose (the hairs not thickened at base); upper leaves smaller, ovate or lance-ovate, 10–17 cm. long, 4–6 cm. wide; panicles terminal and from the uppermost axils, on densely brown-pilose peduncles 4 cm. long or less, together forming a flattish or convex crowded compound panicle 4–7 cm. wide, the pedicels 7 mm. long or less; heads (as pressed) 4–5 mm. high, 6–8 mm. thick; outer involucre of 5 triangular-ovate acute long-ciliate subherbaceous phyllaries 2 mm. long or less, with very short, more definitely herbaceous, glabrous, rather loose tips, the inner phyllaries (subtending the pistillate flowers) about 3, broadly ovate, boat-shaped, obtuse, thin-margined, multivittate, minutely ciliolate, glabrous dorsally or with one or two short bristles above, 5.5 mm. long; pales similar but thinner and flatter; pistillate flowers about 3, their corollas white, tubular, clavate, truncate, 1.5–1.8 mm. long, densely long-pilose except at base; disk flowers numerous, their corollas white, sparsely stipitate-glandular especially at base of tube and on teeth, 4.8 mm. long (tube 1.8 mm., throat thick-cylindric, 2.5 mm., teeth ovate, 0.5 mm. long); achenes (scarcely mature) obovoid, compressed, glabrous, epappose, 3 mm. long.

COLOMBIA: In woods, vicinity of Las Vegas, Dept. Santander, alt. 2600–3000 m., 21–23 Dec. 1926, *E. P. Killip & A. C. Smith* 16124 (type no. 1,351,893, U. S. Nat. Herb.).

Distinguished, among the species with pilose or villous stem, by its very large leaves with long-tapering base.

Polymnia maculata var. **glabricaulis** Blake, var nov.

Caulis et pedunculi glaberrimi; folia (magna, sub-5-lobata) supra sparse tuberculato-hispidula subtus sparse hispidula et secus venas primarias hirsuta, pilis ad basin paullum incrassatis.

MEXICO: Cerro Carrizo, near San José, alt. 1465 m., Tamaulipas, 19 July 1930, *H. H. Bartlett* 10508 (type no. 1,491,521, U. S. Nat. Herb.).

From the three varieties into which I divided[4] this species some years ago, distinguished by the character of their pubescence, the present form is at once separated by its perfectly glabrous stem and peduncles. The plant is also of interest as representing the northeasternmost extension of the range of any form of the species, which has hitherto been known from Zacatecas, San Luis Potosi, and Veracruz south to Costa Rica.

Steiractinia penninervis Blake, sp. nov.

Frutex ramis tuberculato-strigosis et -strigillosis; folia mediocria lanceolato-ovata v. oblongo-ovata acuminata basi lata rotundata v. subtruncata supra scabra subtus minute et dense hispidula ad venas strigosa penninervia venis et venulis subtus prominulo-reticulatis; capitula majuscula subsolitaria breviuscule pedunculata; involucri 1.3–1.5 cm. alti phyllaria extima ovali-ovata v. oblongo-ovata 7–10 mm. longa 3–6 mm. lata basi vix contracta.

Evidently shrubby, alternately branched above; branches rather densely strigose and strigillose, in age glabrate, the hairs with small not conspicuous tuberculate bases; leaves opposite; internodes 1.5–3 cm. long; petioles strigose and strigillose, hirsute-ciliate, channeled above, naked, 1–1.5 cm. long; blades (upper leaves) 6.5–8.5 cm. long, 2.5–3.3 cm. wide, inconspicuously serrulate (teeth about 2–3 mm. apart), above rather harshly strigose and strigillose with slightly tuberculate-based hairs, impressed-veined, beneath strigose or antrorse-hispid on the principal veins, and rather densely hispidulous with antrorse or spreading, very acute, conical, tuberculate-based hairs, featherveined, the principal lateral veins about 12–15 pairs, strongly prominulous-reticulate; heads 1–4 at apex of branches, terminal and solitary in the upper axils, 5–6 cm. wide; peduncles strigose, strigillose, and laxly hirsute, 2–4 cm. long; disk in flower about 1.7 cm. high, 2 cm. thick, in fruit (as pressed) about 1.3 cm. high, 2 cm. thick; involucre about 4-seriate, graduate, the outermost phyllaries 4–5, oval-ovate or oblong-ovate, strigose, hirsute-ciliate, and very minutely strigillose, subherbaceous with short, indurated, 5–8-impressed-nerved base, the next series obovate-oblong or obovate-oval, about 10–12 mm. long, 5–7 mm. wide, obtuse, thinly subscarious-herbaceous, pilose-ciliate, on back sparsely strigose and hirsute or subglabrous, the next series oblong, subscarious, 12–15 mm. long, 3–5 mm. wide, ciliate above, glabrous on back, the inmost series similar but much shorter and narrower, minutely erose-ciliolate, glabrous dorsally; pales scarious, 8–10 mm. long, acutish, narrowed below the apex, minutely ciliolate above on margin and on the thin keel; rays probably about 12–15, neutral, golden-yellow, essentially glabrous, the tube 2.5 mm. long, the lamina elliptic-oblong, 2–3-dentate or-denticulate, about 12–14-nerved (2 of the nerves much stronger), 2.5–2.8 cm. long, 4–7 mm. wide; disk flowers very numerous, their corollas yellow, glabrous, 7.5–8 mm. long (tube 3 mm., throat slender-funnelform, 4 mm., teeth ovate, 1 mm. long); achenes obovate-oblong, 3–3.8 mm. long, compressed, blackish or olivaceous, glabrous on the sides, above narrowly marginate or winged on one or both edges and there ciliolate, the wings or margins adnate to the saucer-shaped pappus-bearing apex of achene; pappus awns about 25, caducous, slender, hispidulous, mostly subequal and about 2.2–3.3 mm. long, a few shorter and only about 0.8 mm. long.

COLOMBIA: Above San Miguel, at edge of páramo, Dept. Magdalena, alt.

[4] Contr. Gray Herb. 52: 33–34. 1917.

about 3000 m., July 1932, *William Seifriz* 398 (type no. 1,572,392, U. S. Nat. Herb.)

Distinguished from all the species of *Steiractinia* previously known, except *S. ocanensis* Blake, by its penninerved leaves. In *S. ocanensis*, of which I have for comparison only a small photograph of a specimen of the type collection (*Linden* (*Schlim*) 183) in the Kew Herbarium, the branches are conspicuously tuberculate by the persistent bases of the hairs, the leaves larger, cuneate at base, apparently much more pubescent on both sides and much less venose, and the outermost phyllaries considerably larger (12–21 mm. long).

Flourensia dentata Blake, sp. nov.

Frutex resinosus glaber valde ramosus; folia lanceolata v. rhombico-lanceolata utrinque acuta penninervia, majora 3.5 cm. lata 1.3 cm. longa utroque latere 1–4-dentata, minora saepe integra; capitula mediocria discoidea apice ramorum et ramulorum solitaria basi 1–3-foliaceo-bracteata; involucri ca. 3-seriati paullum gradati 6–9 mm. alti phyllaria extima lineari-oblonga v. -lanceolata, cetera obovata margine saepius laciniata; achenia sericeo-pilosa.

Much branched probably erect or erectish shrub 28 cm. high and more, the branches mostly erectish, reddish-brown, the old bark gray; leaves alternate, the internodes mostly 5–20 mm. long; petioles about 1–4 mm. long, margined above; blades of the principal leaves 1.7–3.7 cm. long, 5–15 mm. wide, widest below the middle, cuneately narrowed into the petiole, light or yellowish green, coriaceous, featherveined with about 3–5 pairs of usually obscure veins, dentate or dentate-serrate above the cuneate entire base with triangular, acute or obtuse, sometimes apiculate but not mucronate, irregular teeth 1–2 mm. high; branch leaves mostly entire, smaller, lanceolate or elliptic; heads 9–11 mm. high, 4–8 mm. thick, turbinate-campanulate, 20–26-flowered, erect, solitary at tips of usually few-bracted peduncles or branchlets mostly 1–3 cm. long, subtended at base by 1–3 spatulate or oblanceolate entire or toothed leaves 6–13 mm. long; involucre about 3-seriate, slightly graduate, appressed, 6–9 mm. high, the phyllaries rather few, thick-chartaceous, brownish, the outermost linear-oblong or linear-lanceolate, obtuse, the others obovate or oblong-obovate, somewhat ciliolate at apex, with thinner, narrow or broad, toothed to irregularly laciniate margin; corollas yellow, glabrous, 4.4–4.8 mm. long (tube 0.8–1 mm., throat cylindric to slender-campanulate, 3 mm., teeth ovate, 0.6–0.8 mm. long); pales about 8.5 mm. long, with broad scarious margin and rather abruptly set off, semiorbicular, erose and lacerate tip; achenes (not mature) cuneate, somewhat thickened, densely silky-pilose, about 6 mm. long, 1.5 mm. wide; pappus of 2 unequal slender linear-lanceolate hispidulous awns 3–4.2 mm. long, readily deciduous, or sometimes wanting; style branches with deltoid, acute, dorsally finely hispidulous appendages.

MEXICO: Sombreretillo, Durango, 9 Nov. 1925, *S. Juzepczuk* 550 (U. S. Nat. Herb, Herb. Leningrad); "campos guayuleros, ad viam," Terreros near Pedriceño, Durango, 11 Nov. 1925, *Juzepczuk* 609 (type no. 1,492,915, U. S. Nat. Herb.; dupl. Herb. Leningrad).

The only species of *Flourensia* with discoid heads and toothed leaves previously known is *F. ilicifolia* Brandeg., of Coahuila. In that species the

leaves are rhombic-ovate, relatively broader (the blades 1.6–2.4 cm. long, 1–1.7 cm. wide), and repand-dentate with 3–6 pairs of stiffly mucronate teeth.

Verbesina lundellii Blake, sp. nov.

Perennis paucicaulis; caules glandulari-hispiduli et hispidi subsimplices paucifolii; folia majora opposita ovata acuta sessilia basi rotundato-cordatula firma triplinervia reticulata sinuato-denata utrinque viridia scabro-pubescentia; capitula 3 majuscula; involucri 2-seriati 7–8 mm. alti appressi phyllaria lineari-lanceolata acuta hispida; radii ca. 11; achenia anguste alata, pappo bidentato.

Few-stemmed herbaceous perennial, 50 cm. high, simple or with a few short branches above; stems erect, subterete, wingless, 2.5 mm. thick, striatulate, greenish, densely spreading-hispidulous with mostly conical gland-tipped hairs of varying lengths and more sparsely spreading-hispid; principal internodes 3–5 cm. long, the upper up to 10 cm.; leaves mostly opposite (4–5 pairs), with about 4 alternate ones above, sessile, not decurrent; blades of the lower leaves oval or rhombic-ovate, 1.5–3.8 cm. long, 8–23 mm. wide, acute, at base rounded to broadly cuneate, subtruncate at extreme base; blades of the middle leaves ovate, 6–7.5 cm. long, 3.5–4.2 cm. wide, acute or acuminate, at base broadly rounded and minutely cordate, stiff-chartaceous, rather yellowish green especially beneath, triplinerved a little above the base and prominulous-reticulate especially beneath, sinuate-dentate above the entire lower third or quarter with 10–12 pairs of unequal acutish callous-tipped triangular teeth 0.5–1.5 mm. high, above evenly but not densely hispid with antrorse-spreading tuberculate-based white hairs and glandular-tuberculate between them, beneath spreading-hispid on the veins and veinlets and also on them hispidulous with much shorter gland-tipped hairs; upper leaves narrower, lance-ovate, 4.5 cm. long, 1.7 cm. wide; heads 3, about 3 cm. wide, the peduncles aggregated, 3.7–4 cm. long, densely glandular-hispidulous and sparsely spreading-hispid, naked, subtended by linear to subulate bracts 1.2–2 cm. long, 1–2.5 mm. wide; disk (as pressed) hemispheric, 1–1.2 cm. high, 1.3–1.5 cm. thick; involucre about 2-seriate, subequal or slightly graduate, 7–8 mm. high, the phyllaries linear-lanceolate (1.3–1.6 mm. wide), acute, callous-tipped, appressed, subherbaceous essentially throughout, few-ribbed toward base, not densely hispid and ciliate with tuberculate-based hairs and also tuberculate; rays about 11, golden-yellow, pistillate, the tube hirsute, 2 mm. long, the lamina oval, 2-dentate, about 10-nerved, 11–15 mm. long, 5–7 mm. wide; disk flowers numerous, their corollas golden-yellow, 7 mm. long (tube pilose, 1.4 mm., throat subcylindric, 4.8 mm., teeth ovate, 0.8 mm. long); pales yellow above, with blackish keel and erect yellow tips, acute, stipitate-glandular on keel and toward apex, about 8.5 mm. long; disk achenes (immature) obovate-cuneate, glabrous, 4.8 mm. long, narrowly winged above, the wings continuous with the 2 short teeth (0.2–0.5 mm. long) of the pappus.

MEXICO: Among low scrubby oaks in the "encinal" association, on Aguila Mountain, in Salteador range, about 10 km. from Charcas, San Luis Potosi, July-Aug. 1934, *C. L. Lundell* 5392 (type no. 1,589,219, U. S. Nat. Herb.).

A member of the section *Pterophyton*, nearest *V. rothrockii* Robins. & Greenm., in which the pubescence is different, the phyllaries oblong or

elliptic and obtuse, and the principal leaves rather abruptly contracted into a strongly auriculate-clasping base.

Thelesperma scabridulum Blake, sp. nov.

Perenne (?) humile ramosum ubique scabridulum pilis brevibus incrassatis; folia lineari-filiformia apice subulato-acuta integra v. tripartita; capitula parva discoidea apice ramorum solitaria v. terna, pedunculis mediocribus; corollae lobi faucibus breviores; pappi aristae lineari-lanceolatae longe hispido-ciliatae.

Root slender, vertical, apparently perennial; stems several, 5–10 cm. high, erect or ascending, oppositely branched even from the base, densely scabridulous with short, dull white, mostly conical hairs of unequal length, leafy, the leaves mostly equaling or overtopping the heads; internodes mostly 5–10 mm. long; leaves opposite, linear-filiform, 1–3 cm. long, 0.4–1 mm. wide, thick, subulate-pointed, entire or above the middle bearing a pair of similar lobes 3–10 mm. long, sparsely pubescent like the stem, especially toward base, or nearly glabrous; peduncles solitary at apex of stem and branches and in the uppermost axils, densely pubescent like the stem, erect, slender, 0.5–2.7 cm. long; disk hemispheric, 5–8 mm. high (young fruit), 4–7 mm. thick (as pressed); involucre double, pubescent like the stem except on the scarious margins of the inner phyllaries, 4–5 mm. high, the outer phyllaries 3–4, lance-subulate, acuminate, 2–3 mm. long, 0.5–0.7 mm. wide, herbaceous, erect, very narrowly scarious-margined, the inner 7–8, ovate, acutish, 1.5–1.8 mm. wide, with herbaceous center and rather broad yellowish-white scarious margin (0 3–0.8 mm. wide), ciliolate toward apex, connate for 1–1.5 mm. at base; flowers 19–23, all hermaphrodite, their corollas golden-yellow, brown-striped, glabrous except for a few short blunt hairs on the back of the teeth, about 5 mm. long (tube 2 mm , throat cylindric-campanulate, 2 mm., teeth oblong-ovate, unequal, 4 of them 0.8–1.2 mm. long, 1 (the outermost) 1–1.4 mm. long); pales oblong, obtuse, about 4 mm. long, scarious throughout, with the midrib marked by 2 orange vittae, irregularly erose-dentate, ciliolate at apex, sometimes somewhat pubescent along midline; achenes narrowly oblong or obovate-oblong, about 3 mm. long, 1 mm. wide, somewhat thickened, straight or incurved, blackish, thickly and sometimes completely covered with irregular blunt yellowish tubercles, falling united with the pales; pappus awns 2, when well developed lance-linear, 1–1.2 mm. long, long-hispid-ciliate throughout or only above, sometimes reduced or obsolete; style branches with deltoid merely acute not cuspidate tips.

MEXICO: Open alkaline plain near railroad, between La Ventura and Ranchito de San Antonio, south of Gomez Farias, Coahuila, July-August 1934, *C. L. Lundell* 5728 (type no. 1, 589, 220, U. S. Nat. Herb.).

Distinct from any previously known species in its pubescence and dwarf habit.

Calea acoma Blake, sp. nov.

Annua, caule tenui lignescente ramoso glandulari-piloso; folia lanceolata v. lineari-lanceolata acuminata sessilia minute denticulata 3-nervia glandulari-pilosa; capitula solitaria v. terna longe pedunculata radiata mediocria; radii albi; achenia calva glabra.

Slender annual, about 40 cm. high, with few opposite branches, the stem terete, multistriate, up to 2 mm. thick, rather sparsely pilose with many-

celled spreading gland-tipped hairs, glabrate below, the branches much surpassing the main stem; internodes of main stem mostly 2–10 mm. long, of branches 0.8–4 cm.; leaves opposite, 3–6 cm. long, 2–7 mm. wide, slightly narrowed at base, remotely callous-denticulate above middle (teeth 4–5 pairs, 0.5 mm. high or less), slightly revolute-margined, herbaceous, sparsely glandular-pilose on both sides, 3-nerved, the lateral pair of nerves weaker than the costa; heads solitary or ternate at apex of stem and branches, about 1.5–2 cm. wide, the peduncles slender, 2.8–15 cm. long, erectish-pilose especially just below the head and sparsely or densely spreading-pilose with gland-tipped hairs; disk (as pressed) 6–9 mm. high, 7–12 mm. thick; involucre 3-seriate, subequal or slightly graduate, 5–6 mm. high, hemispheric, appressed, the outermost phyllaries lanceolate, acutish, about 1 mm. wide, pale and subindurate below, subherbaceous in terminal half, sparsely ciliate with partly gland-tipped hairs, otherwise essentially glabrous, the others oblong or ovate-oblong, about 2 mm. wide, obtuse or subtruncate, often somewhat erose at apex, with pale base and mostly shorter greenish submembranous venose tip, similarly ciliate; rays about 8, white, the tube spreading-pilose, 2–2.8 mm. long, the lamina cuneate, 7–8 mm. long, 3.5–4.5 mm. wide, unequally 3-toothed (teeth blunt, 1–2 mm. long), 6–8-nerved; disk flowers numerous, their corollas yellow, 3–4 mm. long (tube spreading-pilose with several-celled hairs, 1.5–2 mm. long, throat campanulate, spreading-pilose at base, 1–1.5 mm. long, teeth ovate, 0.5 mm. long); pales acute, lacerate-ciliate, otherwise glabrous, several-vittate, about 4.5 mm. long; achenes of disk narrowly obovoid-oblong, several-striate, black, glabrous, 2 mm. long, bearing at apex a minute whitish annulus (apparently left by the base of the corolla); those of ray similar; style branches finely hispidulous, with acuminate triangular appendages.

Colombia: In open place, western slope of Páramo de Hatico, en route from Toledo to Pamplona, Dept. Norte de Santander, alt. 2800–2900 m., 13 March 1927, *E. P. Killip & A. C. Smith* 20721 (type no. 1,355,717, U. S. Nat. Herb); open hillside, vicinity of Mutiscua, Dept. Norte de Santander, alt. 3300 m., 20–22 Feb. 1927, *Killip & Smith* 19637; Páramo de las Puentes, above La Baja, Dept. Santander, alt. 3500–3700 m., 25 Jan. 1927, *Killip & Smith* 18230.

Closely allied to *Calea longipes* Blake, also a Colombian plant, of which it might almost be regarded as an epappose form. In that species, however, the leaves are shorter and relatively broader, and the gland-tipped hairs of stem and leaves of the new species are normally lacking; a few are present on the peduncles, however, in one specimen.(*Niemeyer* 137)

Calea subcordata Blake, sp. nov.

Frutex, caule dense hirsuto-piloso; folia late ovata obtusa basi leviter cordata brevipetiolata chartacea crenata supra scabra subtus griseo-pilosula 3–5-plinervia subtus lacunoso-reticulata; capitula solitaria majuscula radiata aurea; involucri phyllaria extima ovata herbacea interiora subaequantia vel duplo breviora; pappi paleae 20 lineari-lanceolata achenio minute hispidulo duplo longiora.

Shrub 2.5 m. high or less, with opposite branches; stem stoutish, subterete, striatulate, 2–3 mm. thick, brownish, densely spreading-hirsute-pilose, in age glabrate and gray-barked; internodes 1–6 cm. long; leaves opposite; petioles stout, naked, pubescent like the stem, 3–8 mm. long; blades 2.5–6

cm. long, 2–4 cm. wide, obtuse, bluntly callous-apiculate, at base shallowly cordate or sometimes subtruncate-rounded, above light green, densely tuberculate-hispidulous with antrorse-curved hairs, when young gland-dotted, in age subbullate, beneath densely griseous-pilosulous with spreading hairs and dotted with sessile brown glands; heads solitary at apex of stem and branches, 2.5–3.5 cm. wide, the peduncle stoutish, pubescent like the stem, 0.8–2.8 cm. long; disk (as pressed) 8–12 mm. high, 1–1.7 cm. thick; involucre hemispheric, about 4-seriate, 10 mm. high, the outermost phyllaries about 4, ovate, usually abruptly contracted above the base, obtuse, herbaceous, veiny, densely hirsutulous, appressed, the others slightly graduate, oval-oblong or oblong-obovate, broadly rounded, ciliolate at apex or glabrous, with pale indurate body and shorter, brown, paler-margined, usually ampliate, subscarious tip; rays about 18, yellow, the tube glabrous, 5 mm. long, the lamina oblong, 4-denticulate, 5-nerved, gland-dotted on back, 9.5–11 mm. long; disk flowers numerous, their corollas yellow, glabrous, 6.4–7.3 mm. long (tube 2–2.3 mm., throat funnelform, 3.4–3.8 mm., teeth triangular, with a subapical thickening on back, 1–1.2 mm. long); pales narrow, glabrous, serrulate above or with a lateral tooth on each side, 5–7 mm. long; disk achenes sparsely hispidulous or in age glabrate, 2.8 mm. long; pappus of 20 long-acuminate persistent somewhat unequal awns, the longest 5–7 mm. long.

COLOMBIA: Open hillside, La Isla, Dept. Norte de Santander, alt. 2000–2500 m., 27 Feb. 1927, *E. P. Killip & A. C. Smith* 19808 (type no. 1,354,988, U. S. Nat. Herb.); open hillside, vicinity of Charta, Dept. Santander, alt. 2000–2600 m., 1–11 Feb. 1927, *Killip & Smith* 18898; in thicket, same locality, alt. 2000 m., 1–11 Feb. 1927, *Killip & Smith* 18866.

Related to *Calea trianae* Hieron., in which the relatively narrower leaves are elliptic-ovate to lance-oblong, cuneate or sometimes rounded but not cordate at base, and not closely lacunose-reticulate beneath in the manner of *C. subcordata*.

Calea subcordata var. **hirtella** Blake, var. nov.

Rami dense hirtelli; pedunculi dense hirtelli sparsissime et breviter hispidique.

COLOMBIA: In grassland, Mesa de los Santos, Dept. Santander, alt. 1500 m., 11–15 Dec. 1926, *E. P. Killip & A. C. Smith* 15097 (type no. 1,351,036, U. S. Nat. Herb.).

This plant, described as a semiprostrate to suberect shrub up to 0.75 m. high, agrees with the typical form in all essential characters. The difference in pubescence, which is not due to weathering since it is shown by the young branches and peduncles, is sufficient to separate the plant varietally.

Bahia dissecta var. **anisopappa** Blake, var. nov.

Achenia sparse hispidula pappo irregulari 1–8-squamellato 0.4–2.8 mm. longo praedita, squamellis linearibus vel lanceolatis saepius breviter aristatis; capitula (an semper ?) subdisciformia, corollis marginalibus discum non superantibus inaequaliter 4–5-dentatis vel subbilabiatis (3+1) erectis, staminibus abortivis.

LOWER CALIFORNIA: Sandy soil along La Sanca Creek, below La Grulla,

Sierra San Pedro Martir, alt. 2040 m., 17 Sept. 1930, *I. L. Wiggins & D. Demaree* 4870 (type no. 1, 588, 187, U. S. Nat. Herb.).

Bahia dissecta was described by Gray[5] as having the lobes of the disk corollas "almost equalling the tube and throat together." Rydberg[6] describes the lobes as "much longer than the short funnelform throat," and uses this character, together with the absence of pappus, to distinguish the species generically as his new genus *Amauriopsis*. In specimens dissected I find the corolla lobes varying from slightly longer than the throat to distinctly shorter, and never even approaching in length the combined tube and throat. The discovery in Lower California of the pappose form above described, otherwise indistinguishable from typical *B. dissecta* except by its imperfectly and perhaps abnormally disciform heads and more definitely hispidulous achenes, shows conclusively that the genus *Amauriopsis* cannot be maintained as distinct from *Bahia*. The squamellae in var. *anisopappa* are mainly scarious when small, but when better developed possess a callous midrib continued into the short awn. The achenes in the typical form are described by Rydberg as glandular-puberulent, but are normally so obscurely so as to appear essentially glabrous The presence of much better developed hairs on the achenes of var. *anisopappa* is no doubt correlated here, as frequently elsewhere in Asteraceae, with the development of a pappus.

Dyssodia tephroleuca Blake, sp. nov.

Suffrutescens ca. 20 cm. alta pluricaulis, ramis involucrisque dense albo-tomentosis, foliis et caulibus griseo-tomentosis; folia omnia alterna lineari-filiformia integra ca. 1 cm. longa 0.3 mm. lata; capitula solitaria breviter pedunculata radiata aurea; involucri 6.5–8 mm. alti phyllaria ca. 13 paene ad apicem connata pauciglandulosa, basi bracteolis ca. 8 anguste linearibus apice patentibus involucro demidio brevioribus; achenia parce hispidula; pappi paleae 10 subaequales 3–5-aristatae.

Root about 1 cm thick, vertical; main stems apparently spreading, about 20 cm. long, woody toward base, griseous-tomentose, bearing numerous mostly simple erectish leafy 1-headed branches about 10 cm. long, these slender, densely white-tomentose; leaves erectish, rather flaccid, mostly 8–13 mm long, 0.3–0.7 mm. wide, obtuse, usually minutely apiculate, sulcate above, rounded beneath, bearing about 10 scattered or usually subopposite yellow glands; peduncles erect, naked or few-bracteate, mostly 7–15 mm. long, densely white-tomentose; heads about 12 mm. wide; involucre campanulate, 4–5 mm. thick, the bracteoles obtusish, 1–3-glandular, the proper phyllaries bearing a pair of yellow glands a little below the apex of the connate portion, the free teeth narrowly triangular, acutish, 1.5–2 mm. long, bearing a single gland usually near the base; rays about 12, golden-yellow, the tube glabrous, about 2 mm. long, the lamina oblong-oval, about 5 mm. long, 2.5 mm. wide, 2–3-denticulate, 6–7-nerved; disk flowers numerous, their corollas golden-yellow, 4.2–4.8 mm. long, minutely hispidulous toward base of throat (tube 1 mm., throat slender-funnelform, 2.6–3 mm., teeth ovate, 0.5–0.8 mm. long, with a minute inflexed tooth at apex); achenes

[5] Proc. Amer. Acad. 19: 28. 1883, as *Bahia chrysanthemoides*
[6] N. Amer. Fl. 34: 32. 1914.

very slender, black, multistriate, sparsely hispidulous, 4 mm. long, 0.4 mm. wide; pappus 4–4.5 mm. long, of 10 nearly equal essentially 1-seriate paleae, their oblanceolate paleaceous base 0.5–1 mm. long, the central awn firm, subterete, yellowish, hispidulous, 3–3.8 mm. long, the 2 lateral awns broader, whiter, subscarious, hispidulous on margin, undivided or split for ⅔ their length or less into 2 unequal awns; style appendages deltoid, finely hispidulous, short-cuspidate.

TEXAS: Eight miles north of Rio Grande City, Starr Co., 30 Aug. 1932, *Elzada U. Clover* 1825 (type no. 1,623,834, U. S. Nat. Herb.; dupl. in herb. Univ. Michigan).

Nearest *Dyssodia setifolia* (Lag.) Robinson, but well distinguished by its undivided leaves, much larger involucre, and very different pappus.

Dyssodia bracteata (S. Wats.) Blake.

Pectis bracteata S. Wats. Proc. Amer. Acad. **25**: 155. 1890.
Leucactinia bracteata Rydb. N. Amer. Fl. **34**: 180. 1915.

Specimens (nos. 5530, 5743, 5778) collected by C. L. Lundell at Charcas, San Luis Potosi, Mexico, in July-August 1934 agree perfectly with the type collection, *Pringle* 2403, from calcareous hills at Carneros Pass, Coahuila, which is apparently the only collection of this species hitherto made. It is difficult to understand how Dr. Rydberg was led to establish the new genus *Leucactinia*[7] for the reception of this species. Its long style branches, of course, prevent its reference to *Pectis*, but the principal character on which it was distinguished as a genus is mistaken. In his key (p. 148) Rydberg placed it next to *Chrysactinia* in the group with "pappus of numerous distinct bristles only" (as opposed to the genera with "pappus at least partly squamellate"), and in his generic character described it as with "pappus simple, of 10–20 scabrous bristles." In the specific description, however, he called the pappus bristles "slightly dilated and linear-subulate below." Watson had previously described them as "narrowly paleaceous toward the base." The members of the pappus can, in point of fact, be described about equally well as paleaceous-based bristles or as aristate squamellae; they cannot properly be called scabrous bristles. I find them to be about 12–18 in number, indistinctly 2-seriate, the inner longer and with a linear to lanceolate paleaceous base 1–1.5 mm. long, its thickened costa passing gradually or abruptly into a hispidulous bristle about 3–3.5 mm. long, the outer shorter (about 3 mm. long) and with narrower or obsolescent paleaceous border. The species can be received without difficulty into the rather multiform genus *Dyssodia*. The 1 or 2 pairs of short lobes with setaceous-subulate tips found near the base or sometimes near the middle of some of the larger leaves were overlooked by Rydberg, although mentioned in the original description.

[7] N. Amer. Fl. **34**: 180. 1915.

Pectis propetes var. holochaeta Blake, var. nov.

Folia usque ad apicem setoso-ciliata (setis 14–24-jugis).

MEXICO: On plain, Acatitlan, Dist. Temascaltepec, State of Mexico, 23 Sept. 1933, *G. B. Hinton* 4797 (type no. 1,589,300, U. S. Nat. Herb.); on prairie, Limones, same District, alt. 910 m., *Hinton* 2509 p. p. (mixed with *P. saturejaoides* (Mill.) Sch. Bip, the latter in two forms); on plain, Cutzamala, Dist. Coyuca, Guerrero, 11 Aug. 1934, *Hinton et al.* 6422.

In typical *Pectis propetes* Greenm., still known only from the type collection (*Rose* 2436, from near San Juan Capistrano, Zacatecas), the leaves have only 5–9 pairs of setae, usually borne much below the middle of the leaf, rarely extending a little above the middle. This sort of difference usually indicates specific diversity in the genus, but in this case it is supported by no other clear distinctions. In *P. propetes* the stems become somewhat diffusely branched, and the first one appears to be erect; in var. *holochaeta* there appears to be no erect first stem, and the usually several procumbent stems are simple or subsimple. In *P. propetes* the achenes are rather uniformly and not very densely short-pilose with hairs about 0.5 mm. long; in var. *holochaeta* they are much more densely pilose with hairs about 1 mm. long, usually borne in one or two broad lines with essentially glabrous interspaces. Without knowledge of the amount of variation to which *Pectis propetes* may be subject, it seems advisable to consider all these differences as of only subordinate importance.

Pectis linifolia var. hirtella Blake, var. nov.

Involucri phyllaria dorso subdense hirtella; folia majora setis 2–3-jugis 4.5–6.5 mm. longis donata (jugis 1–2 basalibus, 1 infra medium folii).

MEXICO: On hill, Tanganhuato, Dist. Coyuca, Guerrero, 18 Sept. 1934, *G. B. Hinton et al.* 6606 (type no. 1,589,311, U. S. Nat. Herb).

The type, a considerably branched plant about 7 dm. high, differs from all the numerous specimens of *Pectis linifolia* L. examined from Arizona, Mexico, West Indies, and South America in its hirtellous involucres and in the very long and slender purple setae of the leaves. The involucre of *P. linifolia* is described by Fernald and by Rydberg as glabrous or minutely puberulent, but is glabrous in all the specimens I have examined; and the setae are always basal, 1 or sometimes 2 pairs, rarely none, and only about 1–2 mm. long.

Liabum longifolium (Rusby) Blake.

Munnozia longifolia Rusby, Bull Torrey Club **54**: 313. 16 May 1927.

Liabum hexagonum Blake, Journ. Washington Acad. Sci. **17**: 300. 4 June 1927.

Both these specific names were based on the same collection, *Buchtien* 3079 from Unduavi, Bolivia.

Cirsium trachylomum Blake, sp. nov.

Glabrum subvalidum valde erecto-ramosum capitulis numerosis; folia

principalia oblonga alte pinnatifida sessilia breviter decurrentia apice acuminata subcoriacea pallide viridia, lobis ca. 5-jugis lanceolatis v. oblongis acuminatis subintegris v. parum repando-dentatis margine rigide spinosis et spinulosis, spinis albidis ca. 5 mm. longis; capitula majuscula sicc. campanulata ca. 4.5 cm. alta irregulariter racemosa (1–6 per ramum) in pedunculis nudis v. bracteatis saepius 4–15 cm. longis; involucri basi vix umbilicati paucibracteati (bracteis spinoso-dentatis involucrum vix aequantibus)ca. 7–8-seriati valde gradati ca. 3 cm. alti phyllaria omnia erecta v. subappressa in margine plusminusve lutescenti-indurata et dense ciliolata, exteriora triangulari-lanceolata ad apicem breviter subherbacea spina rigida erecta ca. 2 mm. longa donata, media ovato-lanceolata v. lanceolata spina 2–4 mm. longa erecta donata, interiora (ca. 3–4-seriata) lanceolata-linearia acuminata in margine latiore dense et minute hispidula et ciliolata infra apicem breviter purpurascentia appendice subscariosa anguste triangulari integra minute ciliolata flavescenti-albida ca. 2 mm. longa donata; corollae purpureae, limbo tubo duplo longiore usque ad medium 5-fido, lobis obtusis ad apicem incrassatis; achenium maturum brunneo-nigrescens 4 mm. longum.

Plant essentially glabrous throughout, 1–1.2 m. high, stem pithy, striate, up to 1 cm. thick; leaves rather remote, the principal ones 13–21 cm. long, about 6–10 cm. wide, short-decurrent (wings 1–2 cm long, lobed and spiny-toothed, 1–2.5 cm. wide including spines), light green on both sides, very slightly arachnoid toward base beneath, the lobes acuminate and spinose-tipped, about 2–4 cm. long and 1–2 cm. wide, entire or slightly sinuate-dentate or the lower 1–2-lobed on one side at base, not densely margined with slender prickles or small spines 1–3 mm. long and ending in firm slender spines 5–7 mm. long; upper and branch leaves smaller, dentate or shallowly lobed, not or scarcely decurrent; bracts of peduncles few, 2–6 cm. long, their basal teeth or spines enlarged; bracts subtending head narrowly lanceolate, 1.5–3 cm. long; outermost proper phyllaries about 1 cm. long, 2–3.5 mm. wide below, with indurated whitish or greenish-white base and lucid yellowish-white densely hispidulous-ciliolate margin about 0.3–0.5 mm wide, above 1-ribbed (the rib sometimes glandular), sometimes 1–2-spinulose on each side below apex; middle phyllaries similar but broader (4 5 mm. wide), with 2–3 pairs of weak greenish ribs or nerves below apex, and with broader yellowish white margin (about 1 mm. wide); inner (3–4 series) with narrow greenish center (1–3-vittate) and broader, lucid, apparently viscid, densely and minutely hispidulous and ciliolate yellowish-white margin; whole involucre glabrous (except for the minute hispidity and ciliolation) or with the slightest trace of arachnoid tomentum on the margin of a few phyllaries; corollas 2.7–3.1 cm. long (tube 7–9 mm. long, throat moderately distinct, 9 mm. long, lobes linear, essentially equal, 11–13 mm. long, thickened at apex and often obtusely apiculate); achene glabrous, 4–5 mm. long; pappus whitish, 2 cm. long, the awns all plumose, about 10 of the inner with obscurely thickened tips; anther tips broadly triangular, shortly acuminate; style with obscure node.

LOWER CALIFORNIA: Granitic soil among pines along small canyon above a meadow, La Encantada, Sierra San Pedro Martir, alt. 2225 m. (7300 ft.), 18 Sept. 1930, *I. L. Wiggins & D. Demaree* 4904 (type no. 1,588,186, U. S. Nat. Herb.; duplicate in Dudley Herb. of Stanford University).

This species is not very closely allied to any hitherto reported from Mexico.

Its closest relationships are evidently with *C. andersonii* (A. Gray) Petrak, of California, and *C. rothrockii* (A. Gray) Petrak, of Arizona, from both of which it is entirely distinct.

Gochnatia cardenasii Blake, sp. nov.

Frutex parvus valde ramosus, ramulis compacte flavido-tomentellis foliosis; folia elliptica brevipetiolata ca. 8 mm. longa obtusa integra supra viridia subtus canescenti-tomentella anguste revoluto-marginata parum venosa; capitula 7–8-flora terminalia sessilia saepius solitaria mediocria; involucri 8–9 mm. alti phyllaria e triangulari-ovatis lineari-oblonga acuminata pubescentia.

Shrub "60 cm. high," the numerous straight rigid branches diverging at an angle of about 30–45°, the stem and older branches densely gray-tomentellous; leaves alternate, often with fascicles in their axils, the internodes mostly 5–10 mm. long; petioles 1–2 mm. long, canescent-tomentellous, slender, somewhat enlarged at base; blades elliptic or ovate-elliptic, 5–11 mm. long, 1.5–3.5 mm. wide, cuneate or rounded at base, coriaceous, above glutinous and essentially glabrous, obscurely triplinerved, the veins evident beneath under the tomentum; fruiting heads solitary or rarely paired at tips of stem and branches, usually subtended by 2 or 3 reduced leaves, sometimes with 1–4 abortive heads in the axils below them, when moistened cylindric and about 11–14 mm. high and 2.5 mm. thick; involucre strongly graduate, about 5-seriate, the phyllaries brownish, firm, ribless, ciliolate with partly glandular hairs, erectish-pilose, and somewhat sessile-glandular, glabrescent, the inmost almost cuspidate-acuminate; corollas apparently whitish, tubular, subcylindric, glabrous, 8 mm. long (tube 3 mm., throat 0.7 mm., teeth narrowly elongate-triangular, 4.3 mm. long, erect, 3-nerved, thickened inside at apex); achenes oblong, erectish-pilose, 3.5 mm. long; pappus yellowish-tinged, 9–10 mm. long, of numerous stiffish hispidulous graduated bristles; anthers 6.2 mm. long, including the hairy tails, these about 2.8 mm. long; style branches linear-oblong, 1.2 mm. long, erectish, obtuse, glabrous.

BOLIVIA: Quechisla, Dept. Potosí, alt. 3420 m., Dec. 1932, *M. Cárdenas* 326 (type no. 1,616,163, U. S. Nat. Herb.); Quechisla, Dec. 1931, *Cárdenas* 15 (Gray Herb.).

Readily distinguished among South American species by its yellowish-tomentellous branchlets and tiny bicolored leaves. The rather ample material is in good fruit, but the corollas have practically all fallen; only two perfect ones and an imperfect one could be found in the heads.

Chaptalia anisobasis Blake, sp. nov.

Basi rufo-tomentosa; folia oblongo-elliptica longe petiolata obtusa basi valde inaequalia tenuiter coriacea repanda supra citissime glabrata viridia subtus ochraceo-tomentosa; scapus ca. 25 cm. altus infra glabratus nudus ad spicem dense rufo-tomentosus et squamis paucis anguste triangularibus praeditus; involucri ca. 1.3 cm. alti phyllaria e oblongo-ovatis linearia obtusa; fl. fem. exteriores ca. 20 valde bilabiati involucro breviores, interiores minores etiam bilabiati; achenia immatura breviter rostrata puberula.

Root not seen; leaves 2 or 3 (or more?), apparently erect; petioles slender, naked except toward apex, thinly arachnoid-tomentose, glabrescent, 8–12.5 cm. long; blades oblong-elliptic or ovate-elliptic, or sometimes slightly wider

above the middle, 3.5–6.3 cm. long, 2–2.8 cm. wide, usually strongly inequilateral at base (usually subtruncate or slightly cordate on one side, subtruncate or obliquely curved on the other) and often very narrowly decurrent on apex of petiole for 1.2 cm. or less, shallowly repand chiefly below middle, very narrowly revolute-margined, featherveined, the lateral veins 4–6 on each side, scarcely prominulous above, evident through the wool beneath, the secondaries obscure; scape erect, 20–26 cm. high, slender, thinly arachnoid-tomentose and glabrate except toward apex, there very densely rufous-tomentose and bearing 3 or 4 very narrowly triangular or subulate bracts about 2.5 mm. long; head solitary, apparently nodding; involucre about 6-seriate, strongly graduate, the outer phyllaries oblong or ovate-oblong, obtuse, 1–1.5 mm. wide, the middle ones linear-oblong, 1.3–1.5 mm. wide, obtuse, the inner linear, about 1.5 mm. wide, obtuse or acutish, all with greenish center and purple subscarious margin; outer pistillate flowers about 16–21, essentially 1-seriate, their corollas bilabiate, white, somewhat purplish-veined, glabrous, shorter than the involucre (not fully developed?), erect, the tube 5 mm. long, the outer lip elliptic-linear, 3-denticulate, 4-nerved, 5.3 mm. long, about 1.5 mm. wide, the inner lip 2-parted to base, the divisions linear, obtuse, erect, about 1.2 mm. long; corollas of inner pistillate flowers bilabiate, glabrous, white, 6.4 mm. long, the tube 5 mm. long, the lips erect, the outer 3-lobed to below the middle (lobes narrow-triangular, with incurved blunt callous tips, the middle lobe 1.2 mm. long, the outer lobes 0.8 mm.), the inner of 2 similar lobes 1 mm. long; corollas of hermaphrodite flowers white, glabrous, bilabiate, 8 mm. long, the tube 3.5 mm. long, the throat 2 mm. long, the outer lip subequally 3-lobed to below the middle, the lobes triangular, at apex thickened and papillose inside, 1.5 mm. long, the inner lip of 2 similar lobes 2.5 mm. long; achenes (decidedly immature) subfusiform, short-beaked, somewhat puberulous, a few of the hairs with subglandular tips; pappus bristles numerous, yellowish-white, about 7.5 mm. long, finely hispidulous.

COLOMBIA: Páramos of the Sierra Nevada de Santa Marta, Dept. Magdalena, alt. about 3850 m., July 1932, *William Seifriz* 484 (type no. 1,572,393, U. S. Nat. Herb.).

Close to *Chaptalia meridensis* Blake, of Venezuela, in which the essentially symmetrical leaves are broadly oval, thicker, rather persistently arachnoid above or tardily glabrate, and on petioles only as long as the blade or shorter.

Microseris tenella var. aphantocarpha (A. Gray) Blake.

Calais aphantocarpha A. Gray, Proc. Amer. Acad. **6**: 552. 1865

Microseris aphantocarpha Schultz Bip. Pollichia **22–24**: 308. 1866.

Gray,[8] when transferring his *Calais tenella* (of 1857) and *C. aphantocarpha* (of 1865) to *Microseris*, regarded the former as merely a depauperate state of the latter, and adopted the name *aphantocarpha* for the specific concept on account of the inappropriateness of the name *tenella*. Schultz Bipontinus had earlier transferred these and other species described or listed by Gray in 1857 to *Microseris*, but his paper was overlooked by Gray and by most later authors. The earlier specific name, *Microseris tenella* (A. Gray) Schultz Bip., must of course be adopted for the species, and *aphantocarpha* treated as a variety.

[8] Proc. Amer. Acad. 9: 209. 1874.

ENTOMOLOGY.—*Some undescribed species of* Eristalis *from North America in the United States National Museum.*[1] FRANK M. HULL, University of Mississippi. (Communicated by HAROLD MORRISON.)

Eristalis aztecus n. sp.

Female: Face considerably projecting. Upper half brownish yellow, lower half and cheeks brownish black, shining; pile of face very long, yellow, of lower occiput, white; cheeks bare. Front and vertex dark brownish, more or less opaque, with dense, very long, reddish yellow pile. Eyes densely long pilose. First and second antennal joints shining brownish orange. Third joint more opaque, brownish orange below and black along a narrow dorsal border. Arista extends to facial knob, light reddish with long plumose hairs on basal half, very slightly and gradually thickened basally. Thorax dark brownish, opaque. Pleurae, same color, shining; scutellum brownish red, faintly shining Pile of pleurae, thorax, scutellum, light reddish, tending to golden, very long and dense. Second abdominal segment black, faintly shining, an obscure, reddish shining spot, occupying either side. Third, fourth, and fifth segments shining black. Third with a narrow obscure opaque black band on anterior border and again just before posterior border. Pile of second segment abundant, long, very short on third and fourth, practically absent on fifth. Venter shining, the color is an indefinite mixture of light brown and black.

All femora shining, black, save at the tip, pale yellow. A single row of unusually long yellow bristles at regular intervals on the ventral side of hind femora. Pile long and black. Hind tibiae white on basal half. Middle tibiae save at tip, and fore tibiae on basal half pale yellow, otherwise dark brownish. Fore and middle tarsi light reddish; last two joints of fore and middle and all of hind tarsi dark brown. Wings quite hyaline. Stigma brown. Hind tibiae somewhat flattened; no ciliary brush. Length 14 mm.

The type is a female, no. 42076 U. S. N. M., Real del Monte, Mexico, 9,000 ft. (*H. T. Vanostand*).

This belongs to those neotropical species, strikingly similar to *Eristalis circe* Will., in the pronounced light reddish brown coloration and thick shaggy pile of similar color The ground color of the face is light obscure brown, not shining black and the lower face projects forward less. The shaggy red pile of *circe* continues to the terminal abdominal segment, where as it is limited to the first and second in *aztecus* and grown noticeably shorter on the second

It may be noted that this species resembles *fulvipes* Big. in the dilated posterior tibiae and the color of thorax, scutellum, and the pile; it differs in its very hairy eyes, plumose arista, etc. It must be close to Bigot's *E. inca*, in hairy eyes, plumose arista, and dark thorax covered with reddish pile. It differs in front being brown, not black, with thick long yellow hair and absence of long yellow hair on face. *Eristalis aztecus* traces to *distinguendus* in Curran's Key, differing markedly in color and pile.

[1] Received April 16, 1935.

Eristalis circe Will.

Male: Face considerably projecting downward; shining black, covered with very long, pale brownish yellow hair; cheeks bare, shining black. Vertex shining black, covered with similar hair to that on face, likewise covered with microscopic pubescence. Facial prominence inconspicuous. First and second joint of antennae black, shining. Third joint opaque light reddish brown. Arista lost. Eyes heavily long pilose; pile of lower occiput very shaggy, nearly white, upper occiput tending to reddish. Whole thorax opaque dark brown. Thorax, scutellum and pleurae, densely covered with long shaggy reddish yellow pile, tending to golden.

Abdomen light brownish red, second and third segments faintly shining, fourth quite shining. Second segment with a narrow black transverse band along anterior border, widening medially and becoming a median black spot pointed apically; third segment likewise with a median black spot; fourth with a still smaller black spot. Whole abdomen covered with exceedingly long reddish yellow pile. Venter entirely shining black. Hypopygium shining black. Fore and middle femora light yellow save tip, and hind femora shining black. First two femoral pairs with long black hairs. Last femora with long dense hairs arranged as a brush on outer and inner surfaces, the outer reddish yellow except on extreme tip and the inner black; bristles in bristle-row, yellow. Tibia black, basal half of first pair, basal two-thirds of second, yellow, shining. Fore and middle tarsi yellowish brown. Hind tarsi smoky brown to black. Wings hyaline, veins only with narrow reddish brown clouds, which are probably characteristic. Hind tibiae compressed, without ciliary band. Length 14 mm.

One male, Mexico City, Mexico (*Juan Muller*).

Eristalis fuliginosus n. sp.

Male: Face, cheeks, vertex, front, shining black; microscopic, silvery pile present on all these parts, but most abundant on lower face and cheeks, and here divided by a bare band of shining black; facial prominence large, though not especially prominent, bare. Face and cheeks with sparse, quite long silvery hair. Long black sparse hair on vertex and antennal prominence. Ocelli situated on a distinct prominence. Eyes heavily long pilose, especially anteriorly. Antennae dark reddish brown, microscopically pubescent; arista slender, not thickened, non-pubescent, wiry, light reddish in color. Third antennal joint about one and a half times as long as broad, somewhat pointed apically. Pleurae for most part shining black with sparse long black pile. Disc of thorax and scutellum opaque black, pile thick, but short, growing quite long on scutellar margin, black, center of scutellum with oval, median, opaque yellow spot barely touching posterior margin.

Abdomen black. Second segment opaque, save posterior margins and lateral margins narrowly Third segment opaque save broad transverse shining black band, narrowly interrupted medianly. Fourth entirely shining; pile on margins of second segment and disc of second and third black, some white pile on disc of second only and on margin of third and fourth and hypopygium. Venter entirely black. All the femora shining black, long black pilose, hind femora heavily thickened; all tibiae shining reddish brown, all tarsi reddish orange brown; pile of tibiae and tarsi light; hind tibiae prominently flattened, a groove on inner surface of apical half. Wings smoky brown on outer half, hind tibiae without ciliary brush. Length 12 mm.

Holotype male, no. 42078 U. S. N. M., Attenas, Costa Rica (*Schild and Burgdorf*).

This species is similar to *nigripennis Macq.* in the dark coloration, and the smoky wings of the apical half. Distinctive in the yellow spot on scutellum, which is opaque, and the heavily thickened, 'pinched-in' hind femora with glossy brownish red tibiae. The above characteristics likewise distinguish it from the neotropical *Eristalis scutellaris* Fabs. to which it is allied by the slender, bare, quite long arista. The front in profile is peculiarly flattened.

This traces to my species *Eristalis cyatheus* in Curran's key, but the thoracic pattern is not broken up into spots as in that species. From *precipuus* Will., also with red femora and tibiae it is distinguished by the black color of the abdomen. *Eristalis melanaspis* Wied. has a yellow abdomen and its scutellum is similar to this species, but its femora are dark.

Eristalis bistellatus n. sp.

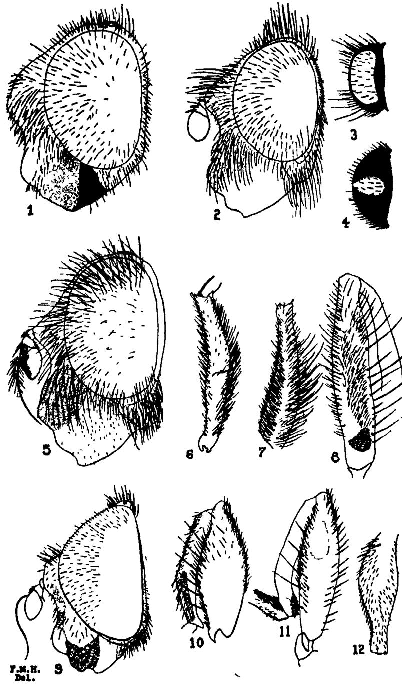
Female: Cheeks black, covered with faint white pruinescense and abundant long yellow hair; a bare spot in middle of face just above mouth, oval in shape and shining yellowish brown. A similar bare spot just above antennae. First joint of antennae yellowish brown, shining, remainder wanting. Front dark brown becoming nearly black at vertex; pile thick and lighter brown in color. Eyes densely pilose save on a narrow posterior strip.

Thorax and scutellum opaque velvety black, pile very thick and black. Scutellum equipped with an extra long tuft of pile on each side near the base. Remainder of scutellar margin bare. First abdominal segment black, opaque, with long whitish pile. A large, nearly square, opaque, pale yellow spot on each side of second segment, narrowly separated by black in the middle. Third segment opaque black, fourth segment similar, except for a transverse band in middle of segment, shining black and narrowly interrupted medianly. A similar uninterrupted band on fifth segment. Pile of abdomen, save on fifth segment short, thick, close, black; on fifth segment it takes the form of very long indefinite median, posterior, and lateral tufts. Second segment of venter light yellow with dark brown median spot. Third brownish black, yellowish in anterior lateral angles. Pleurae opaque black, densely black pilose. All the femora, shining black, densely black pilose, the basal half with some sparse, very long pale pile. Middle femora on posterior ventral side with a long brush of exceedingly dense, long black pile. Anterior tibiae shining reddish brown; hind tibiae shining black, quite flattened and with black ciliary brush on dorsal and vertral surfaces. All the tarsi reddish brown, pile golden; hind metatarsus enlarged. Wings hyaline, faintly brownish. Length 16.5 mm.

Type, a female, no. 42079 U. S. N. M., Piches and Perene, Peru, 2000–3000 ft. altitude.

This species is related to *Eristalis pygolampus* Wd. in the large size, dark color, and broad, flat, dark scutellum, but differing in the less metallic abdo-

Fig. 1.—Lateral view of head of *Eristalis bistellatus* n. sp. Fig. 2.—Lateral view of head of *Eristalis circe* Will. Fig. 3.—Scutellum of *Eristalis diabilis* n. sp. Fig. 4.—Scutellum of *Eristalis fuliginosus* n. sp. Fig. 5.—Lateral view of head of *Eristalis aztecus* n. sp. Fig. 6.—Figure of posterior tibiae from the side of *Eristalis bistellatus* n. sp. Fig. 7.—Figure of femora of *Eristalis aztecus* n. sp. Fig. 8.—Lateral view of hind femora of *Eristalis aztecus* n. sp. Fig. 9.—Lateral view of head of *Eristalis fuliginosus* n. sp. Fig. 10.—Lateral view of posterior femora of *Eristalis fuliginosus* n. sp. Fig. 11.—Lateral view of hind femora of *Eristalis diabilis* n. sp. Fig. 12.—Dorsal view of hind femora of *Eristalis fuliginosus* n. sp.



For explanation of Figs. 1–12, see bottom of opposite page.

men, the presence of the two large quadrate yellow spots, as well as other differences as described. It is slightly similar to *Eristalis surinamensis*, Macq.

Eristalis diabilis n. sp.

Male: Front shining and vertex opaque black. Pile of these areas very sparse, about as long as third antennal joint is wide, of a vitreous black color. Face descending, but not markedly and a median stripe shining vitreous black. A broad band, from epistoma to margin of eyes and thence to just above antennae, of silvery pubescence. The same band bears very scattered, long silvery hair. First and second antennal joints shining black; third dark brown, very short instead of evenly rounded, having an obliquely truncated appearance. Eyes dichoptic, thinly brown pilose.

Dorsum of thorax shining black with a bluish tinge, the color obscured by thinly dusted pollen (or pruinescence), apparently without markings of any kind. Pile of dorsum rather abundant, about as long as half the length of scutellum, pale brownish yellow. Scutellum opaque yellow, narrowly opaque black on the sides, pile sparse, long, black. Pleural pile pale. Abdomen black, faintly shining, the third and fourth segments with a central transverse band more strongly shining. An opaque black band on anterior and posterior margins of third and fourth segments; a pale brownish yellow spot on either side of the second segment, wider than scutellum is long, separated from the lateral margins of the segment by a narrow black border which widens as it proceeds posteriorly to about twice its width anteriorly. Segments two, three, and four with narrow yellow posterior margins.

Legs shining black. All the femora normal at the tip, basal third of hind tibiae and fore and middle tibiae more normally, brownish or brownish yellow. Fore and hind tarsi black; middle tarsi brown. Hind femora slightly thickened in the middle, producing a slight 'pinched-in' appearance at the tip. Wings quite hyaline. Length, 8 mm.

Holotype male, no. 42077 U. S. N. M., and one paratype male, Tacubaya, and Mexico City, Mexico, 4–18 (*John Muller*).

This peculiar little species greatly resembles the one I have discussed[2] under the name of *quadraticornis Macq.* and which more recently Dr. Curran identifies with *meigenii* Wd. From *meigenii* Wd. it differs in the unicolorous thorax, the more widely yellow scutellum, and the absence of yellow spots on the third segment. From *texanus* Hull it differs in the blackened base of scutellum, and the absence of stripes. All three species are quite small and at least *meigenii* Wd. agrees in the peculiarly shaped third antennal joint. The present species is unique among North American *Eristalis* in the dichoptic male, unless the male of *texanus* proves to be dichoptic which seems likely. *E. meigenii* might be considered to be very narrowly dichoptic. The present species, *diabolis*, traces to *meigenii* in Curran's Key, but is more dichoptic, and moreover, *diabolis* also has a small, shining, yellowish spot above the antennae, and a transverse depression about the middle of the front. Older authors have applied the name *Eristalinus* to similar dichoptic species from Europe. The species further resembles *meigenii* Wd. in the pe-

[2] Ohio Jour. Sci. 25: 29. 1925.

culiar type of third antennal joint, in size, bimaculate scutellum and general pattern of abdominal markings. The thorax is unicolorous, however, and the scutellum more widely yellow.

GEOLOGY.—*Tentative ages of Pleistocene shore lines.*[1] C. WYTHE COOKE, U. S. Geological Survey.

For countless ages the relative positions of land and sea have been continually changing. Vast areas that are now dry land are floored by rocks deposited in ancient seas. Many continents and islands are fringed by marine terraces that have more recently emerged and whose shore lines can still be traced by means of their abandoned beaches and other features.

It has been the custom in the past to call such emerged beaches and sea bottoms "raised" or "uplifted," the implication being that they attained their present position above sea level by rising or tilting of the land while sea level, the datum plane to which they are referred, remained constant. Although it is undoubtedly true that the emergence of such features in many places is due primarily to movements of the land, yet these very movements must have affected the level of the sea. If upwarp of the crust of the earth at one place is compensated by downwarp elsewhere, the net effect of crustal movements on sea level is nil, provided that all parts affected are beneath the sea or all are above sea level; but if the land rises and the sea bottom sinks, sea level falls; and if the land sinks and the sea bottom rises, sea level becomes higher. The crustal movements that raised the Pacific coast of the Americas and formed the near-by deeps probably resulted in a world-wide lowering of sea level. It seems likely that the dominant direction of change of sea level due to crustal movements during Quaternary time has been downward.

Another factor that influences the height of sea level is the variable size of the polar and subpolar ice caps. This factor has been called glacial control. When the ice caps are large there is less water in the sea than when the ice caps are small. Glacial stages, therefore, are times of low sea level; interglacial stages are times of high sea level. As the earth is now in a state of partial glaciation, the height of sea level due to glacial control is intermediate between the lows of the glacial stages and the highs of the interglacial stages.

As water seeks its level, a variation in the capacity of the oceanic

[1] Published by permission of the Director of the U. S. Geological Survey. Received May 11, 1935.

basins due to crustal movements or a variation in the amount of water in the oceans due to glacial control produces a world-wide change in the level of the sea. An abandoned shore line in China should stand at approximately the same height as the contemporaneous shore line in Virginia, provided that there have been no crustal movements at either place and disregarding local variations in sea level. Exact correspondence in the levels reported is not to be expected because the measurements are usually made to the abandoned high-tide mark, which varies considerably in height from place to place. With these limitations, it is therefore possible to correlate marine terraces in many parts of the world simply by ascertaining the altitudes of their abandoned shore lines with respect to the present sea level.

It may also be possible to correlate the marine terraces with the sequence of glacial and interglacial stages in North America on the assumption that the oscillations of sea level are due primarily to glacial control. On two previous occasions I have applied this principle in the preparation of correlation tables.[2] The speculative nature of these correlations was emphasized in both papers and it was frankly stated that they could scarcely be expected to prove final. The first attempt was defective because the sequence of shore lines then known was not complete; the second was not acceptible to glacialists because it assumed three interglacial substages within the Wisconsin. Both were incorrect because they were based upon the erroneous assumption that each shore line represents a different interglacial stage or substage.

That this assumption is false appears to be proved by the observations of Stearns[3] on the island of Oahu. He finds that sea level dropped from about 95 feet above its present level to 70 feet and then to 40 (?) feet without the intermediate lower levels that would be expected if each of these highs represented a different interglacial stage. From 40 feet the water sank to about 60 feet below the present sea level and then rose to 25 feet above it. It seems reasonable to suppose that this low level represents a glacial stage and that the 95-, 70-, and 40-foot levels together represent one interglacial stage.

Corroboration of the existence of a low stand of sea level preceding the 25-foot stand is found on the Neuse River 10 miles below New Bern, N. C., where Mansfield[4] reports large truncated cypress stumps

[2] COOKE, C. W *Correlation of coastal terraces* Jour Geology 38: 577 589. 1930, *Tentative correlation of American glacial chronology with the marine time scale.* This JOURNAL 22: 310–312. 1932.

[3] STEARNS, H. T. This JOURNAL 25: 90. 1935.

[4] MANSFIELD, W. C. U S. Geol Survey Prof Paper 150: 134. 1927.

overlain to a height of 26 feet above sea level by sand and clay containing brackish-water shells. An indication that there were probably no intermediate low stands of the sea immediately preceding the 70-foot and the 42-foot stands is suggested by the shape of the shore lines at those levels in South Carolina.[5] These shore lines seem to indicate emergence rather than submergence. An indication that sea level was low before the 100-foot stand is found at Washington, where the Wicomico formation, there presumably of estuarine origin, rests upon cypress stumps that grew about 60 feet below the Wicomico shore line.[6]

The accompanying revised correlation table is still highly speculative. It is still probably defective in many respects, but it is believed to be somewhat closer to the truth than the two previous attempts. The "Princess Anne" terrace, which was credited with a shore line 12 feet above sea level in the second correlation table, is omitted in the new version because I have been unable to confirm the existence of a shore line at that level in South Carolina, where the conditions for its preservation are favorable and where large-scale topographic maps should make its detection easy.

TABLE 1.—TENTATIVE AGES OF PLEISTOCENE TERRACES

Approximate altitude of strand lines		Name of terrace in the southeastern United States	Glacial and interglacial stages
Feet	Meters		
		. . .	Nebraskan glacial stage
270	82	Brandywine	Aftonian interglacial stage
?	?	. . .	Kansan glacial stage
215	66	Coharie	Yarmouth interglacial stage
170	52	Sunderland	
?	?	. . .	Illinoian glacial stage
100	30	Wicomico	Sangamon interglacial stage
70	21	Penholoway	
42	13	Talbot	
?	?	. . .	Iowan glacial stage
25	8	Pamlico	Peorian interglacial stage
		. . .	Wisconsin glacial stage

[5] COOKE, C. W. *Geology of the Coastal Plain of South Carolina* U. S Geol. Survey Bull (in course of publication).

[6] WENTWORTH, C K *The fossil swamp deposit at the Walker Hotel site, Connecticut Ave. and DeSales St, Washington, D C* This JOURNAL 14: 1–11 1924

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

BOTANICAL SOCIETY

265TH MEETING

The 265th meeting was held at the Kennedy-Warren Apts., April 2, 1935.

Program: WM. H. WESTON, JR.: *Recent advances in our knowledge of the sexuality of certain lower fungi.* Since Blakeslee in his epoch-making paper of 1904 first recognized, demonstrated, and defined heterothallism in the Mucorales, the experimental period in the study of sexuality in the fungi which he ushered in has been notable chiefly for the discovery of this condition by other workers, not only in other groups of Phycomycetes but also in the Ascomycetes and Basidiomycetes. Recently, however, a much more complex sexual condition of hermaphroditism involving self sterility with cross fertility toward compatible opposites has been found to obtain in certain Ascomycetes and has been worked out in detail in *Sclerotinia*, where the ascospores are uninucleate and there is a consequent segregation of compatibility or fertility therein; and in *Pleurage*, where the normal binucleate ascospores involve the somewhat more complex situation of the presence in the same binucleate spore of two hermaphroditic entities, each self sterile but reciprocally cross fertile. This condition is much more complex than either the homothallism or heterothallism recognized by Blakeslee, as each individual is not one single separate sex, either male or female exclusively, but is hermaphroditic with highly specialized and differentiated male and femal sex organs and a definite self sterility and cross fertility, the situation on the whole resembling that in some of the flowering plants.

This illuminating condition found in the Ascomycetes is of course too complex to cast any light on the more primitive condition from which these more elaborate ones have evolved. As might be expected, we must turn for such primitive phylogenetically significant situations to the aquatic Phycomycetes. Here Kniep, in *Allomyces javanicus*, has found a condition more primitive and hence probably of more phylogenetic significance, a condition of hermaphroditism with self fertility between heterogamous planogametes distinctively different in size, color and activity and borne in definitely arranged gametangia, notably dissimilar in size and shape. This interesting condition has been corroborated by Hatch in *A. arbuscula* and by Emerson and Weston in other tropical species of the genus. The situation presents a close parallel to that revealed by recent studies in the green algae and is of interest in bridging the gap between the isogamous planogametic fusions in some of the Chytridiales and the hitherto anomalous situation of oogamy in *Monoblepharis* involving large non-motile eggs and small motile sperms.

Of the several examples considered in this discussion these two, at least, give the impression that far more significant and interesting sexual conditions are to be found in the lower fungi than might have been expected from consideration of the classic situations defined as heterothallism and homothallism by Blakeslee thirty years ago.

SPECIAL MEETING

A special meeting was held April 24, 1935, in the Auditorium of the U. S. Department of Agriculture, President WM. W. DIEHL presiding.

Program: L. O. KUNKEL.—*Plant viruses* (illustrated). Some recent ad-

vances in studies on plant virus diseases have been made possible by the discovery that primary lesions are produced by the virus of tobacco mosaic and by many other viruses, that large numbers of closely related strains of viruses are prevalent in nature, and that any one strain of a virus protects against other strains of the same virus, but not against any other virus.

Necrotic primary lesions produced by the virus of tobacco mosaic on leaves of *Nicotiana glutinosa* and *Phaseolus vulgaris* are conspicuous and easy to count. The number of lesions that appear following inoculation with any sample of virus furnishes a measure of the infectivity of the sample, and therefore indicates the concentration of virus in the sample. This method of measuring concentration facilitates quantitative studies on the tobacco-mosaic virus. By choosing appropriate test plants, the method becomes applicable for quantitative studies on a considerable number of other plant viruses.

Many different plant virus diseases have been recognized and studied. The several diseases have usually been distinguished by characteristic symptom differences. The discovery that a large number of different strains of tobacco-mosaic virus may be isolated from bright yellow spots that occur on the leaves of plants having ordinary tobacco mosaic, and similarly that yellow strains of cucumber mosaic may be isolated from plants having ordinary cucumber mosaic, has focused attention on virus relationships. Recognition of these relationships has simplified certain virus disease problems.

Tobacco plants infected with any one of a large number of different strains of tobacco-mosaic virus become immune from other strains of this virus. They are not immune from cucumber-mosaic virus, or from other viruses to which tobacco plants are susceptible. Similarly, tobacco plants infected with any one of several different strains of cucumber-mosaic virus become immune to other strains of this virus, but are not immune from tobacco-mosaic virus, or from other viruses to which tobacco is susceptible The immune reaction is specific and furnishes a dependable means for the identification and classification of plant viruses and the diseases they produce. Little is known regarding the nature of immunity from virus diseases acquired by plants, but the discovery that peach-yellows virus in diseased peach trees can be destroyed by heat treatment that does not injure the trees has furnished favorable material for further work on this phenomenon. (*Author's abstract.*)

EARL B. MCKINLEY.—*Animal viruses* (illustrated).

266TH MEETING

The 266th regular meeting was held in the Assembly Hall of the Cosmos Club, May 7, 1935, President DIEHL presiding; attendance 75. The following were elected to membership: CORABEL BIEN, ARNOLD S. DAHL, JUAN B. DEMAREE, LORENZO D. EAGLES, CHARLES R. ENLOW, LEWIS A. FLETCHER, D. VICTOR LUMSDEN, EUGENE MAY, MAX A. MCCALL, ELIZABETH R. PENDLETON, SHIO SAKANISHI, DEAN R. WICKES.

Program: ANNIE M. HURD-KARRER.—*Plant physiology involved in the problem of the selenium disease of livestock.* Sulphur or sulphate applications to soil containing selenium so reduced the amount of selenium entering wheat plants as to render their grain non-toxic to rats, the selenized control plots without sulphur yielding toxic grain which produced the typical selenium disease on the rats of parallel feeding tests. Other factors influencing selenium absorption by wheat were type of soil and form of selenium. The selen-

ates are more toxic than the selenites, and of the former, the potassium salt was invariably less toxic than those of sodium and calcium. The selenates produce a white chlorosis and pink coloration of the leaves. The selenites on the other hand do not ordinarily produce this chlorosis, but often cause the roots to become reddened. The theory is advanced that the selenites are the more easily reduced in the root, borne out by the fact that more selenium gets into the tops in the case of the selenates. Plants with a high sulphur requirement, notably the Cruciferae, take up the most selenium, and those with the lowest sulphur requirement, certain of the Gramineae, absorb the least. Other crops tested were intermediate, the rate of absorption of the two elements varying together. A theory is proposed to explain the quantitative aspects of the selenium-sulphur antagonism, which suggests the possibility that the toxicity of a non-essential element may in general be conditioned by the relative availability of an essential element sufficiently similar chemically to permit substitution in some synthesized compound and to preclude discrimination by the root. (*Author's abstract.*)

J. E. McMurtrey.—*Distinctive effects of deficiency of certain essential elements on the growth of tobacco plants.* This is a report of the distinctive deficiency effects of N, P, K, Mg, Ca, B, S, Fe and Mn on the growth of tobacco plants. A deficiency of nitrogen is shown by the whole plant assuming a light green color, with more or less yellowing and drying up or "firing" of the lower leaves to a light brown color. A shortage of phosphorus on the contrary, produces a plant that is abnormally dark green in color with in some instances a yellowing or drying up of the lower leaves to a greenish brown to black color. A shortage of potassium and magnesium in contrast with nitrogen and phosphorus deficiency results in localized effects, with chlorosis of the lower leaves as the dominant characteristic. Typical potassium hunger is distinguished from magnesium hunger by the appearance of small necrotic spots or specks at the tips and margins of the chlorotic leaves in the case of the former. In contrast with the deficiency effects of the above elements which are general or occur on the older or lower leaves, are those typically occurring on the new growth or bud leaves and caused by deficiency in Fe, Mn, S, B, or Ca. A deficiency of Fe, Mn or S produce characteristic chlorosis on the younger leaves. The chlorosis resulting from shortages of Fe or Mn resemble each other in that the veins tend to retain their green color but in the case of the latter a necrotic spotting occurs scattered over the leaf which is not true with Fe chlorosis. The chlorosis resulting from S deficiency differs from those just mentioned in that the veins are lighter green in color than the tissue between the veins. A shortage of Ca first becomes apparent as a peculiar hooking downward of the tips of the young leaves composing the bud, followed by a breaking down of these leaves at the tips and margins. If later growth takes place, the tips and margins show a cut out appearance. In contrast with these effects, a deficiency of boron produces a light green color at the base of the young leaves of the bud, followed by a breakdown, which, if not too severe is followed by later growth, thus causing the young leaves to become distorted or twisted at their bases. The tip of the leaf usually remains alive for some time after the base has broken down. The final result with extreme shortages of boron and calcium is the death of the terminal bud. The foregoing contrasts have served as a basis for the construction of a key to the deficiency effects studied (*Author's abstract.*)

M. A. Raines.—*Some experiments with roots.* The elongation of the young

radicles of many plants varies consistently, and under many environmental conditions quite sensitively. The amount of elongation (conveniently expressed as a ratio comparative to the elongation in water-saturated air, as a readily reproducible control condition) promises to have value in descriptions of and specifications for environmental conditions and root-environmental relationships. Radicles for test purposes are obtained by germinating seeds on strips of blotting paper which are suspended in a moist chamber, with the upper ends of the strips dipping into a water trough, so that they are kept moist by capillarity downwards. The seeds are held in position on the strips of blotting paper by means of pieces of wet absorbent tissue paper. Representative data are given of the elongation ratios of the radicles of lentil, tomato, squash, cress, green pea, and wheat under a variety of common experimental conditions. Test interval, 24 hours; volume of test solution 10 ml. per radicle. Disturbances were regularly caused in the elongation of some radicles (notably lentil, tomato, squash, cress, by such substances as "vaseline," paraffine, and white mineral oil coming into contact with the water in which the roots were growing. Other substances found to cause disturbances in root elongation were lubricating oils, waxes, asphalt, resins, metals, and plant products such as sawdust. In addition, the roots were affected in their growth by the *vapors* given off at ordinary room temperatures (25°C ± 5°) by paraffine, "vaseline," mineral oils, and various waxes present in an enclosed space in which the roots were growing, but not in contact with the water containing them. In experiments on the significance of the difference in the elongation of the radicles in water and in the moist chamber, it was found that the smaller the amount of water used per radicle, the closer does the elongation of the root approach that in the moist chamber. This is interpreted as indicating the exertion of a conditioning influence by the growing root on the water around it, and that, in the case of the radicle growing in the moist chamber, it is growing not in air but in a thin film of water which is in equilibrium with the root in the matter of such conditioning influences. (*Author's abstract.*)

CHARLES F. SWINGLE, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

Prepared by Science Service

NOTES

Army Medical Research Board.—The transfer of the Army Medical Research Board from Manila, P.I., to Ancon, C.Z. has recently been effected. The Research Board was organized in Manila in 1900, with LIEUT. RICHARD P. STRONG, Medical Corps, now head of the School of Tropical Medicine, Harvard University, as its first president.

The activities of the board in Manila included research and investigations largely in the field of tropical medicine, particular attention being paid to the dysenteries, cholera, plague, yaws, dengue fever, malaria, filariasis, beriberi, surra and rinderpest. The latter two are diseases of animals. The contributions of the board are too numerous to mention here, as the bibliography includes over 150 titles of scientific articles published in various journals and books.

It is believed that at this time the Canal Zone offers a more promising opportunity for the board than the Philippine Islands. In the Canal Zone

the board will initiate its work with investigations relative to the epidemiology and control of malaria beyond the limits of the sanitated area—an extremely important problem to the Army during tropical maneuvers and campaigns.

It has been recognized for many years that several fevers of short duration, but a fruitful source of incapacity, identical with or closely resembling denque and papatacci or sanifly fever are prevalent at certain seasons in the Canal Zone. The board will also make an effort to identify these fevers with a view to their prevention or abatement in the future. Mycotic skin diseases are extremely common in Panama and a study and investigation of these ubiquitous dermatoses are under way.

Bureau of Fisheries.—At the Chicago meeting of the National Planning Council of Commercial and Game Fish Commissioners, Commissioner FRANK T. BELL outlined plans which he has formulated for cooperation between the Commission, as representative of the Federal Government, and the several States. At the same meeting, TED LITTLE, of the Bureau, was elected secretary of the Council. GLEN C. LEACH, ELMER YIGGINS, TALBOTT DENMEAD and R. H. FIEDLER took part in the proceedings of the meeting.

Commissioner BELL addressed the recent meeting of the Izaak Walton League of America in Chicago, on problems of protecting the salmon fishery of the Columbia river.

In response to a general demand on the part of the public, the Bureau of Fisheries aquarium in the Department of Commerce Building is to be kept open on Sundays during the summer and as long thereafter as attendance warrants. The hours are from 10 in the morning until 4:30 in the afternoon.

ROBERT O. SMITH, of the Bureau's oyster investigation staff, left Washington recently to assume his new duties at Appalachicola, Florida, where he will have charge of oyster pest control investigations in the Gulf area.

National Bureau of Standards.—The honorary degree of Doctor of Engineering was conferred upon DR. LYMAN J. BRIGGS, Director of the National Bureau of Standards, by the South Dakota State School of Mines, Rapid City, S.D., on May 30 DR. BRIGGS delivered the baccalaureate address on the relation of the Bureau to engineering, and later proceeded to the strato-camp near Rapid City, where, as chairman of the advisory committee of the National Geographic Society-Army Air Corps stratosphere expedition, he supervised the final arrangements for the flight of the balloon, "Explorer II."

The John Price Wetherill Medal of the Franklin Institute was awarded to DR. L. B. TUCKERMAN of the division of mechanics and sound on May 15. The award was made in recognition of DR. TUCKERMAN's fundamental improvements in the optical lever and his application of it to his optical strain gage.

E. C. CRITTENDEN, assistant director of the National Bureau of Standards, delivered the opening address at the Twenty-Fifth National Conference on Weights and Measures, on June fourth. The conference (the first since 1931) met at the Bureau on June 4–7, and was attended by 103 weights and measures officials representing 22 States and the District of Columbia, as well as 55 manufacturers of weighing and measuring apparatus and 10 other persons.

National Park Service.—PROF. CAREY CRONEIS, Department of Geology, University of Chicago, and DR. MELVIN BROADSHAUG and DR. V. C. ARNSPIGER, of the Erpi Corporation, were at Washington Headquarters, National

Park Service, June 8 to 10, in connection with final checking on a series of educational films prepared for Civilian Conservation Corps Camps through a cooperative effort between the National Park Service, the University of Chicago, and the Erpi Corporation.

DR. BARNUM BROWN of the American Museum of Natural History spent several days in Washington in early June, at which time he discussed with Park Service officials plans for developing Dinosaur National Monument in Utah.

DR. G. R. WIELAND, Research Associate of the Carnegie Institution of Washington, recently conferred with National Park Service officials regarding proposed developments at the Fossil Cycad National Monument, Wyoming. It is planned to have a committee inspect this area and offer suggestions on the best means of making the scientific features of this monument available to the public.

Carnegie Institution of Washington.—O. H. GISH and K. L. SHERMAN, of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, left Washington the latter part of May for Rapid City, South Dakota, where they have established a ground-station for obtaining continuous registration of the potential gradient and conductivity of the atmosphere These data are being obtained for use in connection with the discussion of the air-conductivity records which, it is hoped, will be obtained on the stratosphere flight under the auspices of the National Geographic Society and the United States Army Air Corps which is scheduled to take place in June.

HENRY M. STANTON, observer in the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, sailed from New York on June 14 for Peru where he will assist in a program of ionosphere-work at the Huancayo Magnetic Observatory.

Insecticidal Society of Washington.—A promising new scientific society, the Insecticidal Society of Washington, has now been in existence several months. It was organized last autumn, with the following officers: chairman, DR. F. L. CAMPBELL; vice chairman, C. M. SMITH, secretary, DR. J. W. BULGER.

Society of the Sigma Xi.—At the annual banquet and meeting of the Society of the Sigma Xi, on the evening of May 14, membership was conferred on DR. JOHN R. MOHLER, chief of the Bureau of Animal Industry, DR. S. F. BLAKE of the Bureau of Plant Industry, and DR. O. S. ADAMS of the Coast and Geodetic Survey. DR. MOHLER delivered an address on *Explorations beyond the microscope*, DR. BLAKE spoke on the taxonomy of the Compositae, and DR. ADAMS on some mathematical aids in map projecting.

Seismological Society of America.—The tenth annual meeting of the Eastern section of the Seismological Society of America, held at the Dominion Observatory, Ottawa, was attended by a number of Washington seismologists. CAPT. N. H. HECK, U. S. Coast and Geodetic Survey, presented a report on the seismological work of the Survey and also led a symposium on a proposal for listing additional information from seismograms. REV F. W. SOHON, S. J., presented a report on *Twenty-four weeks of microseisms.* R. R. BODLE read a paper on *Some factors in epicenter determination*, and FRANK NEUMANN one on *Some new data on long-period waves in epicentral areas.*

Five Years of Plant Patents.—Patented flowers, fruits and other plants have not accumulated very fast since the plant patent law went into effect five years ago, on May 23, 1930. Files of the U. S. Patent Office show only 124 plant patents of all kinds, contrasted with the thousands of patents on mechanical devices and processes that pour from inventors' brains every year.

Four classes have thus far proved sufficient for the arrangement of plant patent records: roses, other flowers, fruits and "plants"—the latter category being a catch-all for everything that is not classifiable as either flower or fruit.

Aside from roses, patented flowers have run rather strongly to carnations, dahlias, chrysanthemums and freesias. Among patented fruits, apples, plums, cherries, grapes and avocados are conspicuous. Patented vegetables are conspicuous by their absence, but there is one patented mushroom.

The highest number of plant patents granted to a single applicant is nine, to the estate of the late Luther Burbank. The Burbank patents include two roses, five plums, one peach and one cherry. There are at present, however, several commercial nursery companies that hold numerous plant patents, sold or assigned to them by the inventors. A number of patents have been granted to breeders in England, Holland, Czechoslovakia and other foreign countries; most of these have been assigned to American firms.

NEWS BRIEFS

The annual meeting of the American Psychiatric Association was held in Washington during the week of May 13.

At the annual meeting of the Trustees of Science Service, new elections to the Board were made, as follows: DR. HARLOW SHAPLEY, director Harvard College Observatory, representing the National Academy of Sciences; DR. HENRY B. WARD, permanent secretary of the American Association for the Advancement of Science, representing that body, and DR. LUDVIG HEKTOEN director of the John McCormick Institute for Infectious Diseases, Chicago, representing the National Research Council. DR. VERNON KELLOGG, secretary emeritus of the National Research Council, who retired as a trustee, was elected honorary vice-president, in appreciation of his long service in the office of vice-president.

The annual meeting of the American Association of Museums was held at the U. S. National Museum during the week of May 20.

The first topographic map made by white men in China, just after the Boxer uprising over a generation ago, has been turned over to the Library of Congress by R. H. SARGENT of the U. S. Geological Survey. Associated with MR. SARGENT in the survey that produced the map were DRS. BAILEY WILLIS and ELIOT BLACKWELDER, now of Stanford University. The expedition had to work under the protection of a Chinese armed escort.

A white oriole, one of the rarest birds in the world, is included in collections turned over to the Smithsonian Institution by DR. HUGH M. SMITH, recently returned from Siam.

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PHYSICS —*The beginnings of physics II The quest for creative concepts*[1] Raymond J Seeger, The George Washington University

Can any good thing have come out of Greece— as far as science is concerned? It seems to be fashionable among scientists to answer this question with a knowing smile And yet, how much is our reply based upon deep understanding and how much upon superficial prejudice? This so-called ignorance of the ancients, is it not often merely a confession of our own ignorance of them? In this instance, indeed, it may be that in refusing to look beyond their quest for general principles we fail to catch a glimpse of their quest for creative concepts For although it is an anachronism to speak of Greek concepts in the Newtonian sense, it is just as truly a libel to deny them in the Archimedean sense And to neglect them altogether is to affirm that science sprang fully developed from the mind of the late renaissance like Minerva from the head of Jupiter, whereas even our most casual glance at history tells us that there is more continuity[2] in the evolution of human thought than we may have power or time to investigate Now and then new types of reasoning do emerge, but these are invariably found to be old methods redefined, reorganized or reemphasized There is never an immediate emancipation from the past So, too, in science changes in the nature of physical concepts have consisted chiefly in sharper analyses of what have previously been taken for granted as self-evident truths For example, Galileo[3] emphasized that the concepts of the Scholastics were meaningless without experimental tests All the same, he retained space and time as part of his own instinctive logic Centuries later Einstein[4] pointed out that even such ideas have to be associated with a set of metric operations, e g , length signifies only those operations by which it is measured (The identity

[1] *The beginnings of physics I The quest for general principles* This Journal 24 501 1934 Part II received March 16, 1935

[2] G Sarton *The history of science and the new humanism* (1930) Chap 1

[3] Galileo *Dialogue concerning two new sciences* (Translated by H Crew and A de Salvio, 1914) p 84

[4] A Einstein *The meaning of relativity* (1923)
P W Bridgman *The logic of modern physics* (1928)

of these with the ones used in the determination of time between widely separated points necessitates the single concept of space-time, which custom expediently divides into space and time—happily justified by the smallness of ordinary velocities as compared with that of light.) And now what Bohr[4] is stressing in his reciprocity-content of Heisenberg's uncertainty principle is the necessity of including, not only the methods, but also the very instruments in the scheme of things so that physical laws must be regarded both ideally and practically as probable descriptions of events indeterminate in space-time. One always used to assign all accidental errors of technique to the fictitious personal equation—often a convenient safety-valve. But the modern matrix formulation of quantum mechanics includes certain ones in real impersonal equations, which must be solved simultaneously with those giving the measured relationships. (Our everyday faith in causality is warranted only because the magnitude of the physical action usually involved is very much greater than that of Planck's quantum of action h.) Despite this changing significance, however, what never has changed has been the need of using the same kind of creative concept that Archimedes introduced in solving the problem of the king's crown.

As the story goes, King Hieron of Syracuse knew the royal goldsmith so well that he asked Archimedes (c. 287–212 B.C.) to ascertain the genuineness of a newly made gold crown without injuring it. Of course, the crown looked like gold and it felt like gold, but was it solid gold? Any direct test would be indecisive inasmuch as the crown might contain an unknown metal inside. What was needed was a property characteristic of materials and observable by indirect means. This restrictive generality led to the beginning of theoretical physics. For the fact that the head of the goldsmith was at stake meant that flimsy philosophizing would never do. There would have to be predicted some unique relation that could be determined practically. Any concept created from experiential appearances would have to be experimental in its outlook. And this is what we mean by a creative concept, namely, one that is adequately descriptive in its definition and experimentally significant in its relation to other concepts. One can hardly suppose that Archimedes analyzed his problem in this way —more likely he accepted all this intuitively. Yet it is really too bad that our usual picture of him is that of a nudist running down the street and panting "εὕρηκα." For his naïve haste from the most famous bath in history is apt to give us an impression of accidentality,

[4] N. BOHR: *Atomic theory and the description of nature.* (1934).

whereas it signified the enthusiastic climax of his quest for a creative concept. One might more profitably view Archimedes actually taking his bath in his customary listless fashion. Certainly he was doing more thinking than bathing as is evidenced by Plutarch's[6] report that occasionally he had to be carried by absolute violence to bathe. But his phenomenal success is not to be attributed solely to his genius. Scattered in the historical background were isolated cases of experiments and a continuous growth of mathematics. What he did was to unite these two methods by giving mathematical proofs for mechanical practices, thereby producing that powerful, but strange, approach to nature, mathematical physics (much to the disgust of Plato, who looked upon matter as being in the form of imperfect images of perfect ideals). For this reason Archimedes has been rightly called the *Newton of antiquity*. We shall now examine some of these antecedents of his work.

An experiment consists primarily of observation, measurement and repetition; in so far as these are controllable, the experiment is said to have good precision. It is possible to show that the development of the individual sciences can be interpreted in terms of their ability to obtain concepts that can be thus determined precisely. For this enables the power of the mathematical reasoning inherent in economic symbolism to be utilized in obtaining new relations among the concepts, which, in turn, may serve as a system of *checks and balances* or indicate new fields for planned research. Now the real failure of Greek science lay in its lack of such precision. It was not that no fine observations were made or that only crude measurements were attempted, but that the experiments were seldom repeated. For it is in the lack of controllability that the importance of neglected factors is often revealed so that an accurate method may not produce good results because of its wanting precision. By way of illustration, suppose someone measured the pressure of various volumes of a given mass of gas. He might find that it increased with decreasing volume. On the other hand, another observer might note a decrease. And both could be true, because the possibility of the influence of an additional factor had not been considered, viz., the change in temperature. Of course, if only one factor is variable, lack of discrimination is of no great moment. The following is an example of such a fortunate occurrence in Greek investigation.

Just how Pythagoras of Samos (fl. 532 B.C.) discovered the relation between the frequency of sound and the length of the string producing

[6] *Plutarch's Lives Life of Marcellus.*

it is largely a matter of conjecture. Perhaps, he received his information from the priests[7] of Egypt while he lived there. On the other hand, the tradition of his conscious use of the experimental method gains credence when we recall that he made a science out of arithmetic by transferring it from the tradesmen's abacus to the philosophers' papyrus. (And what better example of how he molded *the queen of the sciences* out of the mud along the Nile than the Pythagorean theorem which generalized the 3–4–5 rule-of-thumb?) According to a popular story, as he was passing a blacksmith shop one day, he was impressed with the different musical notes that were emitted when the hammers struck the anvils. Observing that the hammers differed only in size, he surmised that the strings of the lyre might owe their harmony to their various lengths. Much to his surprise, he found that strings with lengths in the ratios 12:8:6 produced tones bearing musical relationships with one another. With the ratio 12:6 the longer string gave a tone an octave below that of the other; the ratio 8:6 was found to correspond to the musical interval of a *fourth*, and the ratio 12:8 to that of a *fifth*. Indeed, all the tones of the lyre could be thus expressed as simple numerical ratios of a single fundamental one. It was only natural that this fact should be exploited at a time when general principles were being sought in every particular phenomenon. The distinctive contribution of the Pythagoreans in this regard was that theirs was a quest for unity in form rather than in matter itself. Their search for the basic design of the universe was in the domain of numbers. How easily geometry was included in its scope! For had not a cube 12 edges, 8 corners and 6 faces? How readily astronomy fitted in the scheme; for there were 7 planets (including the sun and the moon at that time) corresponding to the seven strings of the lyre! Moreover, each of these was supposed to emit a divine note as its celestial sphere rotated. This unheard music of the spheres inspired much thought and contemplation, e.g., Kepler's *Harmonice Mundi* with his celebrated harmonic law (third). Even matter was found to be susceptible of classification according to this principle of number; for the four regular solids, namely, tetrahedron, octahedron, icosahedron, cube, were looked upon as symbolizing the four elements fire, air, water and earth respectively. (The later discovery of the last regular solid, the dodecahedron, was embarassing until someone realized that it signified the whole universe.) How far these awe-inspiring analogies could be carried became a problem for philosophers, and not for mere

[7] H. Helmholtz: *On the sensations of sound.* (3rd ed. 1895, translated by A. J. Ellis.) p. 1.

physicists. The fact remains, however, that there have been other consequences more important than these unwarranted speculations. One is the famous quadrivium of early medieval education: absolute numbers (arithmetic), applied numbers (the studies presided over by the nine muses—called collectively music), magnitude at rest (geometry), magnitude in motion (astronomy). Furthermore, the search for simple numerical relations has played no mean rôle in the formulation of modern physical theories. More than once a hypothesis has been rejected or accepted on the basis of the simplicity of its mathematical formulation. For instance, the experiments of Regnault were even questioned at one time because they did not conform to the simple law of Boyle and of Mariotte. The early rejection and later acceptance of Prout's hypothesis (1815), that all atomic weights are integral, reminds us of the powerful demand for simple numerical regularities. And so we must ever be on guard that our science does not distort its reflected view of nature, that it does not substitute its own convenient simplicity for nature's incomprehensible multiplicity, that it does not altogether hide synthetic processes behind its analytic harmony. To illustrate, what accounts for the universality of simple harmonic motion? Is nature characteristically simple and harmonic? On the contrary, this arises from the customary procedure of neglecting higher order terms of the Taylor expansion of the potential energy about a position of equilibrium—justifiable for small displacements only. Hence, we have to beware always of the fatalistic mysticism of numbers, as the later history of the Pythagorean school itself revealed. It is significant, however, that mathematics and experiment should have been so closely associated at the beginning of physics. For without experiment mathematics is physically meaningless and without mathematics data are physically incomprehensible. In other words, it is equally difficult to listen to someone speak in an unknown language as it is to hear one converse incoherently about this and that. What makes facts worthwhile is their ordering, not their almanac-like compilation. As Poincaré[8] has so well expressed the idea: "Science is built up with facts, as a house is with stones. But a collection of facts is no more a science than a heap of stones is a house." Indeed, we would go one step further and say that it is no more a mere organized collection than a house is a home. The human spirit broods over the chaotic facts of nature until they warm with cosmic life. Creative concepts make science a functioning organism as well as a mechanical organization.

[8] H. POINCARÉ: *Foundations of science* (Reprint 1929, translated by B. HALSTAD.) p. 27.

Other experiments that are recorded dealt with the proof of the corporeality of air—a fact first suggested by Anaximander, but disregarded by Anaximenes. (Cf. Voltaire's[9] erroneous notions about air a century after Boyle's work.) In the fourth book of Aristotle's *Physics*[10] we find such experiments described. One due to Anaxagoras demonstrated "that air is a physical substance by inflating bladders and showing their strength of resistance to compression." A second, that of Empedocles, pointed out the same conclusion by means of a water-clock, i.e., an open vessel with a small hole in the bottom for the water to flow. Suppose the vessel is emptied and inverted in a container of water, while one's finger is held over the aperture. The water will not rise owing to the presence of the air. These experiments are particularly remarkable in that they were cited to refute specific fanciful speculations.

We turn our attention again to the rapid development of mathematics which preceded the work of Archimedes, the *greatest mathematician of antiquity*. Although Socrates' (c. 470–399 B.C.) *theory of ideas* was of little value to the direct study of matter, it replaced ingenious sophisms with reasoned proofs and thereby stimulated mathematical investigations because of its emphasis on form. For example, consider the triangle. Regardless of its size, shape or substance it always has the sum of its angles equal to 180° (in Euclidean space). Thus universal truths can be reaped without the chaff of incidental conditions. Now the history of physics itself can be said to be a continual search for just such generality. At the time of Socrates, however, its great significance was chiefly its stress upon a rational reality that was not materialistic; hence, it was not many years before mechanics joined mathematics as an abstract study. Properly speaking, we should say that the seed of the *theory of ideas* was planted by Pythagoras and that its cultivation in moral and aesthetic fields was the special task of Socrates. The Academy of Plato (c. 428–348 B.C.), who was intimately acquainted with the Pythagorean, Archytas of Tarentum, utilized it in mathematics. Nevertheless, Plato's main interest in this subject lay in the educational value of its clear-cut definitions and of its rigorous reasonings in the training of philosophers. Above his porch was the following inscription for those entering: "Let none that is ignorant of geometry enter my doors!" But nothing was said about the mathematics of those leaving. What his method accom-

[9] *Oeuvres complètes de Voltaire* (Firmin-Didot 1874) 7: 41–45.
[10] ARISTOTLE: *The physics*. (Translated by P. WICKSTEED and F. M. CORNFORD 1929) Book 2, Section 6

plished, therefore, was more the development of mathematical interest than of interesting mathematics. (His physics was worthless, as may be appreciated by reading his *Timaeus*.) This impetus given to the study of mathematics led gradually to its divorce from philosophy so that mathematics was finally studied for the sake of mathematics. This was particularly true in Alexandria where cosmopolitan influences minimized irrelevancies in the search for truth. In the famous museum of this city (c. 300 B.C.), dedicated to the Muses, began a period of investigation that is outranked only by the modern era. Indeed, the *Elements* of Euclid, i.e., 13 books on geometry, have survived as have few other works. Their pedagogical discipline has been of inestimable value owing to the author's synthetic method of deducing his theorems from certain definitions, postulates and axioms set out at the start. Although modern geometers reject the unique validity of the fifth postulate of Book I (the so-called parallel postulate), they are still indebted to Euclid for showing how any single geometry has to be constructed logically. The immediate effect of the *Elements* was to mold the form of the Mechanics of Archimedes of Syracuse, the foremost thinker of the Alexandrian school.

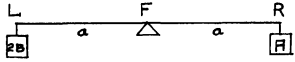
The very legends that have enveloped the inventions of Archimedes (Cf. Lucian's story of the use of reflected sunlight to set the Roman ships on fire) are a measure both of the respect in which he was held and of his genius. Even to-day we are amazed at his powerful use of mathematics. In order to consider his physical studies in some detail, we shall only mention his outstanding mathematical contributions: viz., the quadrature of the parabola by a modification of Eudoxos' method of exhaustion, (the primitive form of integration), the evaluation of π between the limits of 3 10/70 and 3 10/71 (3.14287 and 3.14083), the discovery and analysis of the spiral bearing his name, the determination of the ratio of the area of a sphere to that of its great circle (4:1) and of the ratio of the volume of a sphere to that of its circumscribed cylinder (2:3). (A picture of the last was sketched upon his tomb at his own request.) It is important to realize that these high mathematical attainments made it possible for him to solve such a physical problem as the equilibrium of a right segment of a paraboloid of revolution immersed in a liquid, and that he was here concerned with a creative concept, the center of mass. The substitution of a symbolic mass-point for an irregular solid had already been used previously in practice, but was first computed mathematically by Archimedes for a parallelogram, triangle, trapezium, and a parabolic segment. Moreover, all these proofs were based on the law of the

lever so that he first had to derive the law in a way which we shall now consider.

All his proofs follow the method of Euclid in the postulation of self-evident truths. The first three of the seven postulates that head the first book,[11] *On the equilibrium of planes*, are as follows:

> (1) "Equal weights at equal distances are in equilibirum, and equal weights at unequal distances are not in equilibrium but incline towards the weight which is at the greater distance."
>
> (2) "If, when weights at certain distances are in equilibrium, something be added to one of the weights, they are not in equilibrium but incline towards the weight to which the addition was made."
>
> (3) "Similarly, if anything be taken away from one of the weights, they are not in equilibrium but incline towards the weight from which nothing was taken."

These are used in propositions 6 and 7 to deduce the law of the lever, i.e., *Two magnitudes whether commensurable or incommensurable balance at distances reciprocally proportional to the magnitudes.* For from



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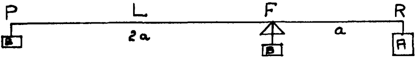

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Figs 1–2—Illustrations used in Archimedes' derivation of the law of the lever

(3) follows the converse of (1), viz., that weights which balance at equal distances are equal. Otherwise, it would be possible to remove the excess weight and have equilibrium, which is absurd on the basis of the principle of sufficient reason and symmetry (the essential reason for the first part of postulate 1). We shall now use this conclusion to illustrate Archimedes' reasoning for the simplest case of one weight

[11] T L. Heath. *The works of Archimedes.* (1897) p. 189.

A being double another weight B. First suppose two weights A and $2B$ are in equilibrium (Fig. 1) at the same distance from each side of the fulcrum. Then they are equal, i.e. $A = 2B$. Now divide one of the weights, say the one $2B$ at L, into two equal parts B and transfer each of these in opposite directions to a distance a from L (Fig. 2). These two weights B are symmetrically located with respect to L and therefore are in equilibrium (postulate 1), but their center of mass at L is still in equilibrium with the weight at R. Thus the entire system remains in equilibrium after the displacement. The weight B at F, however, can now be removed inasmuch as it is supported by the fulcrum. And so B balances A at a distance twice as great as $2B$ did. This method can be easily generalized to include any case.

Mach[12] has pointed out that the above reasoning is fallacious as far as proving something new is concerned. Criticisms[13] of Mach's views notwithstanding, it would be surprising if the mere knowledge of the variables, weight and length, were sufficient to determine their functional combination. Where, then, is this relationship assumed in the proof? It is assumed in the displacement from L. For this involves the tacit assumption that weight and length each enter in the condition for equilibrium only in the first degree. Suppose the law were of the second degree. In the set-up of Fig. 1 we have for equilibrium

$$Aa^2 = Aa^2$$

But the positions in Fig. 2 give for equilibrium

$$A/2(a+a)^2 + A/2(a-a)^2 = Aa^2.$$

or

$$2Aa^2 = Aa^2.$$

On the other hand, if the law is of the first degree, the second case gives

$$A/2(a+a) + A/2(a-a) = Aa$$

or

$$Aa = Aa.$$

In other words, it is the use of the concept of center of mass with its inherent linear distribution that makes the displacement possible and this is an application of the very law of the lever which we started

[12] E. MACH: *The Science of mechanics.* (4th ed. 1919, translated by T J MCCORMACK) Chap. 1.

[13] C. SINGER: *Studies in the history and method of science* (Contains an essay by J. M. CHILD entitled *Archimedes' principle of the balance and some criticisms upon it*) 2: 490.

out to deduce. We have completed a vicious circle with all the dignity of logic. Where did we first err? The fact is that the basic law of statics is experiential and occurs in nature in many equivalent forms; it must be implied in any proof that deals with observed relations. Despite the sanity of expecting to discover experiential laws only in actual phenomena, thinkers have been attacked by a mania for Euclidean demonstrations again and again. They have made many attempts to ascertain the fundamental law of statics, e.g., they have discussed the meaningless question as to whether the law of the lever is more basic than the law of the inclined plane. Yet reversible demonstrations show that these are equivalent and only emphasize their essential similarity. If theory demands definite postulates as starting places, truth itself is insufficient as the criterion for them. It was many years, however, before *convenience*[14] came to be recognized as the basis of selection, and John Bernoulli's principle of *virtual work* was finally accepted in this sense as the fundamental one from which the specific laws of statics are to be obtained. It is noteworthy that Archimedes had in his grasp the necessary conditions for such equilibrium, viz., the balancing of forces and their lever-like distribution. And yet, what is most significant about Archimedes is that he appreciated the extrapolation of his laws to elements beyond his immediate experience; he used his concept to predict. This is epitomized in his boast: "Give me a place to stand on, and I will move the earth." And he actually did move Marcellus' attacking army with his huge levers in the forms of catapults, etc.

We have already mentioned his classic work on hydrostatics. He began the first of his two books *On floating bodies*[15] with the following definition of a fluid: "Let it be supposed that a fluid is of such a character that, its parts lying evenly and being continuous, that part which is thrust the less is driven along by that which is thrust the more; and that each of its parts is thrust by the fluid above it in a perpendicular direction if the fluid be sunk in anything and compressed by anything else." Then in proposition 7 he probably gave his method of solving the problem of the crown, viz., "A solid heavier than a fluid will, if placed in it, descend to the bottom of the fluid, and the solid will, when weighted in the fluid, be lighter than its true weight of the fluid displaced" (Archimedes' principle). Let us apply this to the problem of the crown. Consider a lump of gold having the same weight as the crown in air. Weigh the gold and the crown in

[14] H. Poincaré: op. cit. pp. 106, 125, 173, 208.
[15] T. L. Heath: op cit. p. 253.

water separately and compare their losses in weight. If the crown is made of pure gold, it will have the same loss of weight as the gold lump. The basic concept employed is specific gravity, i.e., the ratio of the weight of a body in air to that of an equal volume of water; hence, the problem can also be solved by the direct consideration of density, or rather, its reciprocal, specific volume, for different substances of the same weight have different volumes. Thus the volume of the displaced water can be used to determine the composition of the crown. This is the method Vitruvius[16] mentions as being the one Archimedes used. This interpretation seems to us less likely because no proposition in Archimedes' works is directly concerned with this idea, whereas, proposition 7 is proved in a thorough manner. It is inconceivable that he would have omitted the proof of so important a method. It might appear that the fact of the bath would help answer this dilemma. In either case, however, he could have obtained a critical clue from the water. The first method would have been assisted by his surmising that the buoyant effect of the water varied characteristically with different materials (for the same weight of substances). On the other hand, the difficulty with the second method was the determination of the volume of the highly ornamented crown. The overflow of the water might have suggested the way to obtain this from immersion of the crown in a full vessel. At any rate, in both cases the essential feature was the need of a concept that was adequate because of its uniqueness and its generality as well as the additional factor that it had to be creative, i.e., it had to predict, directly or indirectly, a practicable experiment. Obviously, a concept, such as characteristic shapes of the atoms, would have been useless because of their indeterminacy. We note also the intuitive use of the factor of simplicity in that the specific gravity was used and not the sum of its square and its cube root, which, nevertheless, satisfies all the other demands. The consummate skill of Archimedes rested in his ability to choose a simple creative concept.

We shall briefly mention some of the inventions of the period before considering the later activities of the Alexandrian school. To Archytas is credited the pulley and the screw (also a child's rattle that Aristotle recommended as something good to keep children from breaking things about the house); to Archimedes is credited the endless screw, the hydraulic screw and the compound pulley; to Ctesibios of Alexandria, the force-pump, the hydraulic clock and the hydraulic organ; to Heron of Alexandria, a steam-engine, a siphon and many automatic

[16] M. VITRUVIUS: *De Architectura*. Book 9, Section 3.

devices. Of greater scientific interest is the ingenious determination of the diameter of the earth by Eratosthenes of Cyrene (c. 273–192B.C.), who was a librarian of the Museum. (The Pythagoreans had already introduced the globular form of the heavenly bodies because of the simple perfection of the sphere.) His method consisted of determining the distance D between two cities on the same meridian,

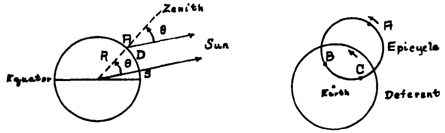

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Fig. 3.—An illustration of Eratosthenes' method of determining the diameter of the earth. Fig. 4.—An illustration of Apollonios' epicycle description of the motion of the planets.

Meroe (near Alexandria) and Syene, and then observing the angle the sun's rays made with the zenith at the former when the sun was at the zenith of the later (Cf. Fig. 3). This angle was the same as that subtended by the radii to these points. Consequently, the radius R could be determined from the relation $D = R\theta$. The observed data[17] were $D = 5040$ stades and $\theta = 7°15'$. The ancient use of different values of the stade in various localities makes it impossible to check the accuracy absolutely to-day. On the basis of the stade[18] being equal to 516.73 feet, the polar diameter was 3925 miles as compared with the modern value of 3949.99 miles. The importance of this method is its use of quantitative observation. This was exemplified even better later by another Alexandrian, Claudios Ptolmaeos (c. 138 A.D.), whom Sarton[19] praises as having performed "the most remarkable experiment in antiquity." It was a study of the refraction of light.

Although the rectilineal propagation of light was well-known to Euclid and inevitably aroused his interest because of its applicability to the geometry of perspective, his *Catoptrics* revealed either a poor account of what he did know or else a good account of what he did not

[17] *Geographica Strabonis* (recognovit A. Meineke 1866) 1: Book 2.
[18] J. L. E. Dreyer: *History of the planetary systems* (1906), p. 175.
[19] G. Sarton: *Introduction to the history of science*. (1927) 1: 274.

know. It was Heron who noted the law of reflection and proved that it was equivalent to the principle of the shortest optical path (Cf. Fermat's Principle of Least Time). The search for the law of refraction was made by Ptolemaeos by a method quite different from that of Archimedes. The latter deduced observable relations from postulates;

TABLE 1.—PTOLEMAEOS' DATA FOR HIS LAW OF REFRACTION

ANGLE OF INCIDENCE (i)	ANGLE OF REFRACTION (r)	i/r[a]	$\sin i/\sin r$[a]
	(1) AIR TO WATER		
10	8	1 25	1.25
20	15 5	1.29	1 28
30	22 5	1 33	1 31
40	29	1 38	1 33
50	35	1 43	1 34
60	40 5	1 48	1 33
70	45 5	1 54	1.32
80	50	1 60	1 29
		Average	1 31
	(2) AIR TO GLASS		
10	7	1 43	1 43
20	13 5	1 48	1 46
30	19 5	1 54	1 50
40	25	1 60	1 52
50	30	1 67	1 53
60	34 5	1 74	1 53
70	38 5	1 82	1 51
80	42	1 90	1 47
		Average	1 51
	(3) WATER TO GLASS		
10	9 5	1 05	1.05
20	18 5	1 08	1 08
30	27	1 11	1 10
40	35	1 14	1 12
50	42 5	1 18	1 13
60	49 5	1 21	1 14
70	56	1 25	1 13
80	62	1 29	1 12
		Average	1 11

[a] Computed by the author

the former arrived at laws from observable data. Thus we have the beginning of the application of the inductive method in science in addition to the deductive one; to-day both are still necessary, neither is sufficient alone. And yet, as is well known, Ptolemaeos failed to obtain the correct form of the law, which was discovered much later by Snell. We emphasize the word form; for the data of Ptolemaeos was not at fault (Cf. Table)[20a]. His failure was partly owing to the fact

[20a] *L'Ottica di Claudio Tolomeo da Eugenio.* Riddotta in Latino (pubblicata da G. Govi 1885) a. Sermo Quintus, b. Introduzione.

that his trigonometric functions were crudely defined and partly to the fact that he was intent upon getting a simple law. As Govi[20b] has shown, his data conform more to a law of the quadratic type than to a simple proportion, e.g., $r = a\,i + b\,i^2$, where i is the angle of incidence, r the angle of refraction and b a constant much smaller than the constant a so that the second term is negligible for small angles. All in all, Ptolemaeos was not far from modern science. It is in the field of astronomy, however, that his creative power is best known inasmuch as his *Almagest* (Μεγίστη Σύνταξις) with its complete Ptolemaic system became the embodiment of Aristotelian cosmology. To understand its scientific significance we turn back to the interest aroused in this branch of applied mathematics by Plato.

Up to the time of the Attic philosophers the chief astronomical problem had been to account for the diurnal motion of the sky and was usually solved by the hypothesis that the stars and the planets were attached to a rotating sphere. In the Pythagorean scheme, however, a daily revolution of the earth was supposed to take place about a primordial fire-center (not the sun), which was never seen on account of an interposed counter-earth. Both of these explanations failed to take cognizance of the irregular motions of the planets. So Plato proposed the problem to his students with the hint that they use "uniform and ordered" motions in its solution. Eudoxos, the originator of the *method of exhaustion*, which was the ancient analogue of the modern theory of limits (Cf. Euclid: Book XII), gave an ingenious geometric answer. He considered every celestial body to be on the equator of an individual sphere rotating uniformly about its polar axis. To account for the retrograde and latitudinal motions of the planets, he further assumed that the poles of these planetary spheres were also attached to a sphere concentric with the first, but rotating with a different angular velocity about a differently directed polar axis. Since these still proved to be inadequate for the description of the observed motions, other spheres were similarly introduced so that four spheres in all had to be associated with each of the planets and three with either the sun or the moon. (All these spheres were to be regarded as independent of one another.) Finally, one additional sphere was necessary for the entire group of fixed stars. This purely kinematical approach to astronomical motions was the forerunner of other nondynamical theories that held sway for many years because of their adequate description. One of these was suggested by Calippos of Cyzicos (n. 370 B.C.), who added a sphere in each case for Mars, Venus and Mercury as well as two for the sun and two for the moon.

The ones for the planets were to produce retrogression without altering appreciably the synodic period, i.e., the time between successive conjunctions of the sun and moon. In the case of the sun the spheres were necessary to describe the unequal lengths of the seasons, which had been noted in 432 B.C. by Meton and Euctemon at Athens. The most startling modification, however, was made by Aristotle (c. 384–322 or 321 B.C.). Lacking the insight of the mathematician he insisted upon having real mechanical spheres in contact with one another. And then in order to prevent the motion of the sphere of an outer planet from being communicated to that of an inner one, he had to add a few more spheres—22 in all. Thus Aristotle's theory required 55 spheres for the heavenly bodies as compared with 34 for that of Calippos and 27 for that of Eudoxos. The system was becoming too cumbersome. Fortunately, its abandonment was hastened by the discovery that the planets appeared brighter at times, as if they moved closer to the earth. No system of rigid spheres was sufficiently flexible to permit this so that about all that could be retained of the Aristotelian system was its geocentricity, nevertheless, his authority in this particular outweighed the geoheliocentric proposal of Heraclides of Pontos (c. 388–315 or 310 B.C.), i.e., that Mercury and Venus revolved about the sun while it revolved with the other bodies about the earth (Cf. Tycho Brahe's extension of this, that all the planets revolved about the sun, which revolved about the earth). Indeed, even the complete Copernican-like hypothesis of Aristarchos of Samos (fl.c. 280 B.C.) had to wait for Copernicus to expound its daily rotation of the earth and its increased size of the universe to account for the fixedness of the stars. This delay was assisted by the epicyclic theory stressed by another astronomer, Hipparchos of Nicaea (c. 136 B.C.), who noted also a 48″ advance or precession of the equinoxes each year (the modern value is about 50″).

Apollonios of Perga (c. 260–200 B.C.), *the great geometer*, who wrote eight classic books on conic sections, first applied epicycles to astronomy. Their value in the description of planetary motions is evident on examination. Consider a planet moving on a circle (the epicycle) with a period of one sidereal year while the center of this circle, in turn, moves in the same sense on another circle (the deferent) with the period of the planet's revolution. At some points B and C (Fig. 4) the motions will annul each other so that the planet will appear at rest. From C to V via A the motion will be progressive with an increase of speed from C to A and a decrease from A to B. From B to C the motion observed on the earth will be retrograde. In this way the motions

of the outer planets can be explained qualitatively. For the planets Mercury and Venus the deferent was given the period of the sidereal year and the epicycle that of the revolution (about the sun on the modern view). As for the sun and moon, which do not show retrograde motions, the motion on the epicycle and that on the deferent were considered to be in the opposite sense. Moreover, the hypothesis of eccentric circles was found to be so useful in describing certain irregularities that Hipparchos used it to fully explain the motions of the sun and the moon. But his greatest contribution was not so much his use of epicycles as it was the beginning of accurate observations that were carried on for three centuries and were thus available for later theoretical study. Indeed, the distinguishing feature of the system of Ptolemaeos was the making of the deferent eccentric in the case of the moon and the five planets. Various minor corrections that also had to be made, need not concern us in our present discussion.

It is particularly important to interpret the Greek attitude to this system correctly. It was not regarded even by Ptolemaeos himself as an actual representation of the planetary motions, but it was considered merely a means of computing the positions of the planets at future times; it was a creative concept. The cumbersome geometry had to be employed in lieu of any algebra at all.

In conclusion, we would emphasize the unmistakable direction that the Alexandrian school pointed out to the early seekers of knowledge, viz., mathematical analysis applied to concepts for the purpose of experimental predictability. That this quest for creative concepts was pursued more in astronomy than in physics was owing to the fact that the former was free from the entangling preconceptions and the snarling misconceptions of philosophy, whereas the latter retained intimate relations with philosophical speculations. Later the pressure of mind as superior to matter stifled physics completely. And yet, we must be careful not to disparage the thought of an age by considering its thinkers as indeterminately banded together. For the brilliant torch of research has been handed down in the main from individual to individual, from group to group, without regard to popular pluralities. Hence, the contributions of Greece to the development of physical concepts should be measured by the blazing peaks her pioneers discovered and not by the dark lowlands in which their associates rambled.

PHARMACOLOGY.—*The toxicity of sodium cyanide and the efficiency of the nitrite-thiosulphate combination as a remedy for poisoned animals.*[1] A. B. CLAWSON, JAMES F. COUCH, and H. BUNYEA, Bureau of Animal Industry.

The poisonous qualities for sheep of potassium cyanide and of hydrocyanic acid have been discussed briefly in former papers and the results that may be expected by treating the poisoned animals with sodium nitrite and sodium thiosulphate in combination have been pointed out.[2] More recently the writers have had an opportunity of testing the toxicity of sodium cyanide for sheep and the nitrite-thiosulphate combination as a remedy for animals poisoned by it. It is proposed in this paper to present the results of tests with sodium cyanide and briefly to compare them with similar results obtained in the experimental work with potassium cyanide and with hydrocyanic acid. Such a comparison seems especially fitting as the animals used in the experiments with the different cyanides had been subjected to very similar conditions and during the respective investigations were handled in the same way.

TOXIC AND LETHAL DOSES OF SODIUM CYANIDE

In determining the toxic and lethal doses of sodium cyanide, when administered as a drench in a water solution, 17 experimental tests were made on 14 sheep. The dosages and results are shown in table 1.

TABLE 1.—QUANTITIES OF SODIUM CYANIDE GIVEN TO SHEEP IN A DRENCH AND THE EFFECTS PRODUCED WHEN NO REMEDIES WERE USED.

Date 1935	Sheep		Quantities[a] given and effects produced		
	No.	Weight kg	Symptoms	Sickness	Death
Jan. 19	1457	34 92			34.66
19	1453	36.73			34 30
19	1482	38 55			32 69
19	1474	37 64			13 95
14	1467	53 06			5 78
14	1471	31 75			5 56
16	1472	39 91			5 32
18	1479	29 02			5 28
14	1468	42 63			5 22
18	1453	36 73		5.20	
18	1476	37 64			5.19
16	1466	35 83		5 10	
18	1469	43.99			4.92
16	1454	46 49	4 82		
14	1466	35.83	4 63		
16	1453	36 73	4 57		
16	1455	30 84	4 15[b]		

[a] The quantities are given as milligrams of sodium cyanide per kilogram of animal's weight.
[b] Symptoms very mild, consisting only of a stimulation of the respiration

[1] Received March 26, 1935.
[2] This JOURNAL 24: 369–395, 528–532, 1934; 25: 57–59, 272–276. 1935.

One sheep was used three times and one was used twice. Each of the other animals was used in a single experiment. In 7 additional cases a solution of 1 gram of sodium nitrite and 2 grams of sodium thiosulphate in 15 c.c. of water was injected intraperitoneally at periods ranging between 1.5 and 4 minutes after the cyanide was administered. These are shown in table 4.

The sodium cyanide solution was carefully prepared and checks made so that each c.c. of solution contained 21.003 mg. of sodium cyanide equal to 11.147 mg. of the cyanide radical (CN), or the equivalent of 11.575 mg. of HCN.

In all cases the dosages were computed as milligrams of sodium cyanide per kilogram of animal weight.

As shown in table 1, a quantity of sodium cyanide equivalent to 4.15 mg. per kg. of animal weight was the smallest dose given. As the effects were very slight, consisting of a mild stimulation of the respiration, and as somewhat larger doses gave correspondingly more marked results, this quantity (4.15 mg. per kg.) is evidently very close to the minimum toxic dose.

The minimum lethal dose is somewhat in doubt, but evidently is close to 5.22 mg. per kg. of animal weight. Sheep 1468, the animal killed by this quantity; sheep 1479, killed by 5.28 mg., and sheep 1476, killed by 5.19 mg., had received no previous drenchings of cyanide. As compared with these, sheep 1453 made sick by 5.20 mg., had been poisoned three times previously by cyanide, the last time on January 17, when it had been given 3 m.l.d. of hydrocyanic acid, followed by an intraperitoneal injection of the nitrite-thiosulphate combination, and sheep 1469 which died following the administering of 4.92 mg. had been given two previous doses of 3 m.l.d. each of hydrocyanic acid, followed by the nitrite-thiosulphate combination. It is possible, although not clear, that the previous treatment may have somewhat modified the results. It is evident that the m.l.d. does not exceed 5.22 mg. per kg. of animal weight.

COMPARATIVE TOXICITY OF CYANIDE WHEN GIVEN IN DIFFERENT FORMS

For comparison with potassium cyanide and hydrocyanic acid, the minimum toxic and minimum lethal doses are given in table 2. In this table the dosages are given in terms of the substances actually administered and of the cyanide radical (CN) equivalents.

Based on the smallest quantities of the substances themselves that produced visible effects, hydrocyanic acid, potassium cyanide, and

TABLE 2.—RELATIVE QUANTITIES[a] OF KCN, HCN AND NaCN REQUIRED, WHEN GIVEN AS A DRENCH, TO PRODUCE SYMPTOMS IN AND TO KILL SHEEP.

Substance given	Minimum toxic dose		Minimum lethal dose	
	As substance given	As CN equivalent	As substance given	As CN equivalent
HCN	1 05	1 01	2 29	2.20
KCN	2 43	.95	5 57	2 23
NaCN	4.15	2 20	5.22	2.77

[a] Dosages given as milligrams per kilograms of animal weight

sodium cyanide bear the approximate relationship represented by the values 1:2.3:4. That is, sodium cyanide is one-half as toxic as the potassium salt and one-fourth as toxic as hydrocyanic acid. If considered on the basis of their cyanide equivalents, their ratio is 1:1:2.2.

The ratios for the minimum lethal dose are somewhat different, being 1:2.4:2.3, when based on the substances actually administered, and 1:1:1.26, if based on the cyanide equivalent. Apparently sodium cyanide is less poisonous than either hydrocyanic acid or potassium cyanide, while there is no appreciable difference between the two latter forms.

The relationship between minimum toxic and minimum lethal doses of the three forms differ somewhat. For hydrocyanic acid and potassium cyanide the relationship is nearly the same, it being approximately 1:2 in both cases. For sodium cyanide it is close to 1:1¼. That is, with HCN and KCN, about twice as much is required to kill as to produce visible effects, while with sodium cyanide the lethal dose is only about 25 per cent greater than the minimum toxic dose.

As the efficiency of any remedial measures in cyanide poisoning is closely related to the promptness with which it is given, or, more correctly, the stage of illness when it is administered, a comparison of the rates at which the stages of poisoning develop when the different forms of cyanide are administered is of considerable interest. The various stages overlap so that no actual sharp boundary exists between them. In most cases, however, three points could be determined fairly closely. These are: (1) symptoms, or the time when the respiratory movement began to show the effect of stimulation; (2) collapse, or when the animals fell and were unable to get to their feet; and (3) death. Considering the cases in which fairly accurate observations were obtained, and eliminating such as were influenced by the administration of remedies, averages, times between the giving of the cyanide and the appearance of the effects, were obtained. These are shown in table 3.

TABLE 3.—SHOWING THE TIME FROM THE GIVING OF CYANIDE IN THE THREE FORMS (HCN, KCN, AND NaCN) AND VARIOUS EFFECTS

Form in which given	Effect	No. of cases	Time to effect					
			Minimum		Maximum		Average	
			Min.	Sec.	Min.	Sec.	Min.	Sec.
Hydrocyanic acid	Symptoms	28		20	2			50
	Collapse	23		50	51	30	5	52
	Death	11	12	30	51	46	30	16
Potassium cyanide	Symptoms	79		30	3	00	1	7
	Collapse	80		30	23	00	2	46
	Death	13	6	00	56	00	25	49
Sodium cyanide	Symptoms	24		30	1	45	1	00
	Collapse	18		30	9	50	2	59
	Death	11	8	00	90	00	34	39

Although table 3 is based on too small a number of cases for positive conclusions, it furnishes certain information. The form in which the cyanide is administered as a drench in water solution has no significant influence on the time it takes symptoms to develop. Apparently the time to collapse is somewhat longer when hydrocyanic acid has been given than when potassium or sodium cyanide has been administered. However, the average time in the hydrocyanic acid cases is in part due to two animals that appear to have been unusually resistant. One of these collapsed after 24½ minutes and one after 51½ minutes. With these eliminated the average time was 3 minutes 33 seconds. Of the 23 cases, 17 (or 75 per cent) collapsed in 3 minutes or less. Following the administration of potassium cyanide there were likewise two prolonged cases, one lasting 19 minutes, and one 23½ minutes before collapse. Without these, the average time is 2 minutes 17 seconds. Of the 80 cases 80 per cent collapsed in 3 minutes or less. With sodium cyanide the average is essentially the same as for the potassium cyanide cases. Of the 18 cases, 13 (or 72 per cent) collapsed in 3 minutes or less.

Taking all facts into consideration, it is not apparent that any essential differences exist in the rate at which illness develops following the administration of the three forms of cyanide under consideration. If any one of the substances acts more slowly than the others, it is the hydrocyanic acid.

THE EFFECTIVENESS OF THE REMEDY USED

As previously stated, 7 animals that had received sodium cyanide were treated with the nitrite-thiosulphate combination. Each animal

was injected intraperitoneally with 15 c.c. of a solution containing 1 gram of sodium nitrite and 2 grams of sodium thiosulphate, the two solutions being mixed just before being injected. The quantities of sodium cyanide given these animals varied from 2.5 to 3.15 times the m.l.d. The remedy was administered in from 1½ minutes to 4 minutes after the cyanide. The results are shown in table 4.

TABLE 4.—SHOWING THE EFFECTS OF THE NITRITE-THIOSULPHATE COMBINATION ADMINISTERED INTRAPERITONEALLY AS A REMEDY FOR SHEEP POISONED BY SODIUM CYANIDE

Date 1935	Sheep		Dose m.l.d	Time in minutes from giving drench of NaCN to			Result
	No.	Weight kg		Symptoms	Collapse	Giving remedy	
Jan. 18	1482	38 55	2 5	0 75	3 25	3 75	Recovery
18	1480	47 62	2.75	1 00	1 75	1 50	Death
18	1481	42 63	2 75	1.5	2 25	2 25	Death
18	1457	34.92	3 00	1 0	3 72	4 00	Recovery
18	1477	41 72	3 00	0 5	1 75	3 25	Death
18	1478	38.55	3 00	1 0	2 5	3 00	Recovery
16	1473	40 82	3 15	0 75	1 00	2.00	Recovery

Four of the 7 cases, including 3 of the 4 given 3 m.l.d. of sodium cyanide recovered. As shown by the few cases the nitrite-thiosulphate combination is as effective against sodium cyanide as against potassium cyanide[3] poisoning, but apparently somewhat less effective than against hydrocyanic acid.[4]

SUMMARY

When given to sheep as a drench in water solution, 4.15 mg. of sodium cyanide per kg. of animal weight produced symptoms of poisoning and 5.22 mg. or more killed, and these quantities are considered to be the approximate minimum toxic and minimum lethal doses, respectively.

Basing the doses on the CN content, sodium cyanide is somewhat less toxic than potassium cyanide or hydrocyanic acid.

Following the administration of sodium cyanide the average time to the appearance of symptoms is approximately 1 minute, to collapse 3 minutes, and to death 34½ minutes. Taking into account the probability of experimental error, these respective periods are about the same as for poisoning by potassium cyanide or by hydrocyanic acid.[4]

The nitrite-thiosulphate combination was effective in 57 per cent of the cases in which it was tried.

[3] This JOURNAL 24: 528–532. 1934.
[4] This JOURNAL 25: 272–276. 1935.

PALEONTOLOGY.—*Notes on the genus* Breviarca.[1] LLOYD WILLIAM STEPHENSON, U. S. Geological Survey.

The name *Breviarca* was introduced by Conrad[2] in 1872 as a subgenus of *Trigonarca* Conrad (not *Trigonoarca*). He did not specify a genotype, but named two examples, *Trigonarca perovalis* Conrad, from the Snow Hill member of the Black Creek formation of North Carolina, and *Trigonarca saffordi* Gabb. The former species was later erroneously described by Conrad[3] under the name *Trigonarca* (*Breviarca*) *carolinensis*. The type of the true *Trigonarca saffordi* (Gabb)[4] came from the Midway group (Eocene), Hardeman County, Tenn., and is now known to be a *Cucullaea*;[5] Gabb originally assigned it to *Arca*.

Meek[6] in 1876, treated *Breviarca* as a subgenus of *Trigonarca* and named *Trigonarca perovalis* Conrad as an example. The first author who definitely designated a genotype for *Breviarca* was Stewart[7] who in 1930 selected *Trigonarca saffordi* (Gabb) Conrad, the second example cited by Conrad. Emphasis is to be placed on the fact that Stewart's selection pertained to the specimen figured by Conrad (his pl. 2, fig. 3), which, as shown below, was a specimen identified as *saffordi* from the Woodbury clay of the Matawan group, Haddonfield, New Jersey, and was not from Hardeman County, Tenn.

Whitfield,[8] in 1885 treated *Breviarca* as a genus and accepted the specific name *saffordi* for the New Jersey material. He says, "The specimen which I have figured on plate 12, figs. 11 and 12, appears to be the same with that used by Mr. Conrad for generic figures in 1872, and I have made the figures as accurately as it is possible to measure the specimen."

The specimen to which Whitfield refers is a right valve preserved in the Academy of Natural Sciences of Philadelphia, and is accompanied in the same tray by 13 other smaller shells, 9 left valves and 4 right valves; the lot is from Haddonfield and bears the number 13141. This lot has been kindly lent to me by the authorities of the Academy. I

[1] Published by permission of the director, U. S. Geological Survey, Washington, D. C. Received June 10, 1935.

[2] CONRAD, T. A. Acad. Nat. Sci. Philadelphia, Proc 24: 55, pl 2, figs. 3, 4. 1872.

[3] CONRAD, T A Rept Geol. Survey North Carolina. 1: App. A: 3, pl. 1, fig. 4 1875. See also STEPHENSON, L. W, North Carolina Geol. and Econ. Survey. 5: 110 1923.

[4] GABB, WM. M. Acad. Nat. Sci Philadelphia, Proc., 2d ser., 4: 397, pl 68, fig. 38 (not fig 37). 1860.

[5] HARRIS, G. D. Bull. Amer Paleontology. 1: no 4: 51–53, pl. 3, fig 11; pl. 4, figs. 1, 2. 1896.

[6] MEEK, F. B. Rept U. S Geol. Survey Terr. 9: 90–91. 1876.

[7] STEWART, RALPH. Acad. Nat. Sci. Philadelphia Special Publication 3: 86. 1930.

[8] WHITFIELD, R. P. U. S. Geol. Survey Mon. 9: 87–88, pl. 12, figs. 11, 12. 1885.

have carefully compared the large right valve with the figures given by both Conrad and Whitfield, and am convinced it is the specimen figured by them; it is marked with a green and a red diamond. Further evidence is afforded by two card labels in Conrad's handwriting, to which specimens had been glued, one bearing the name *Trigonarca saffordi* Gabb, and the other *Trigonarca* (*Arca*) *saffordi* Gabb.

It is clear from the foregoing facts that the Haddonfield specimen, which must be accepted as the genotype of *Breviarca*, was incorrectly referred to Gabb's species *saffordi* and that it is in need of a new name. I therefore propose the name *Breviarca haddonfieldensis*, and designate as holotype the large right valve from Haddonfield, figured by Conrad in Academy of Natural Science Philadelphia Proceedings, vol. 24, p. 55, pl. 2, fig. 3, 1872, and by Whitfield in United States Geological Survey Monograph, vol. 9, p. 87, pl. 12, figs. 11, 12, 1885. The specimen is adequately described by Whitfield. Twelve of the 13 shells accompanying the holotype (9 left and 3 right valves) belong to the same species as the figured specimen. The thirteenth shell, a right valve, differs from the others in form, and resembles *Breviarca umbonata* (Conrad), from the Snow Hill member of the Black Creek formation of North Carolina; this shell has been placed in a separate vial.

It follows that the genotype of *Breviarca* is *Trigonarca saffordi* (Gabb) Conrad (= *Breviarca haddonfieldensis* Stephenson), and not *Cucullaea saffordi* (Gabb).

In 1923 I referred Conrad's species *Trigonarca* (*Breviarca*) *perovalis* and five other associated species, to the genus *Striarca*, which is based on *Arca centenaria* Say, a species from the Miocene of Maryland. The principal common character which was thought to indicate this congeneric relationship, was the transversely striated triangular ligamental area. After further consideration I am now of the opinion that, although the Miocene and Cretaceous species do possess this feature in common, and are related, there are sufficient differences in form and ornamentation to warrant retaining Conrad's *Breviarca* for the Cretaceous species.

BOTANY.—*The status of* Pellaea compacta (*Davenp.*) *Maxon, and a probationary method in systematic botany.*[1] JOSEPH EWAN, University of California. (Communicated by W. L. JEPSON.)

There occurs at elevations of 6500 to 8800 feet in the mountains of southern California an endemic fern whose systematic status has vari-

[1] Received April 2, 1935.

ously shifted. *Pellaea compacta* (Davenp.) Maxon was first published by J. G. Lemmon as var. *californica* of *Pellaea Wrightiana* Hook. in 1882.[2] The following year George E. Davenport published *Pellaea Wrightiana* var. *compacta*,[3] based on material from the same general locality (San Bernardino Mts.) as that studied by Lemmon. Maxon clarified the *Pellaea* confusion in the Southwest by delimiting what had long been taken *sensu latissima* as *Pellaea Wrightiana*, of which he had summarily said in 1901 "extremely variable,"[4] and by proposing in 1917 *Pellaea compacta*[5] as the name, now in full specific rank, for the endemic high-montane fern of southern California. Munz and Johnston considered the characters for this species and its indubitable relative, *Pellaea mucronata* (D.C. Eaton) D.C. Eaton, as not varying together, and therefore in 1922 combined the oldest varietal name with *Pellaea mucronata* to constitute var. *californica* (Lemmon) M. & J.[6] Subsequently Maxon[7] and Jepson[8] have maintained this fern in species status.

My first introduction to *Pellaea compacta* in the field was very possibly in the locality at which W. G. Wright first collected it, though I was unaware of the fact at the time, on the slopes of Mt. San Bernardino at 7500 feet elevation in the range of that name (*Ewan*, July 22, 1928). Although Maxon[9] gives a more general locality, from the text of Davenport's varietal description I believe that Wright must have collected it there. Moreover, the Wright collection seen in the Eaton Herbarium by Maxon and considered by him as being collected on Mt. San Bernardino at "7000 feet" is very probably from the same station, if not collected at the same time as the specimen Davenport had before him when he described his var. *compacta*. My conclusions regarding Wright's collections are reached by studies made particularly at the Los Angeles Museum, where they are well represented. I found here collections of the same species differing but slightly in the wording of their sketchy labels, which upon a close examination could be unquestionably considered as of the same collection. *Pellaea compacta* grows on the higher slopes of Mt. San Bernardino along the old trail, now little used, that leads from Mill Creek (precisely from Forest Home, a resort at 5300 feet in that

[2] LEMMON, J G *Ferns of the Pacific Coast* (San Francisco, 1882) p. 10

[3] DAVENPORT, GEO E. *Cat. Davenport Herbarium Suppl.* 46 1883 (fide MAXON, Proc. Biol Soc Wash 30: 183. 1917, not seen).

[4] MAXON, W R *List of ferns and fern allies of North America north of Mexico*, etc. Proc. U. S. Nat Mus. 23: 634 1901.

[5] MAXON, W. R. *Notes on western species of* Pellaea. Proc Biol Soc. Wash. 30: 183 1917

[6] MUNZ, P A & JOHNSTON, I M. *Distribution of Southern California Pteridophytes.* Amer. Fern Jour. 12: 106 1922

[7] MAXON in ABRAMS, LEROY. *Illus Flora Pacific States* 1: 31 1923.

[8] JEPSON, W. L. *Man. Fl. Pl. Calif.* p. 33. 1923.

[9] MAXON Proc. Biol Soc. Wash 30: 183 1917.

Fig. 1.—a. *Pellaea compacta* (Davenp.) Maxon Typical plants; Islip Trail, near Islip-Hawkins Divide, 7,500 ft., San Gabriel Mts., *Fosberg & Ewan* 4891. b. *P. compacta.* Atypical (ecologic) plants from lower margin of its range; Big Cienaga above Crystal Lake, 6,500 ft., San Gabriel Mts. *Ewan* 2704. c. *P. mucronata* (D. C. Eaton) D. C. Eaton. Typical plant; Cajon Pass, 4,000 ft., San Bernardino Co., *Ewan* 5564.

watershed) to Dobbs Cabin[10] and eventually to the summit. It may be found poking out from beneath large boulders on the gravelly talus slopes thinly populated by very fine veteran Jeffrey Pines. It persists when such slopes are transformed into unsightly "burns" and the insolation much increased.

Though passing through a considerable size range (blade at maturity falling about two averages: 3–5 or 8–12 cm. long), the plants in their optimum habitats show a group of constant morphological characters and match other collections from similar montane elevations through the region occupied, in the compactness and configuration of their blades. I have observed and collected this fern whenever botanizing in the higher mountains, continually marvelling at its distinctness in the field and at its "intermediate" states. I consider "typical" *Pellaea compacta* to be represented by such a collection as *Lemmon*, May 30, 1876 (UC), likely a topotype (postulating Mt. San Bernardino as the type locality), and *Pellaea mucronata* by such collections as *Geo. B. Grant* 920 from "Sierra Madre Mountains" (i.e. San Gabriel Mountains "behind" Pasadena and San Gabriel Valley) and *Braunton* 750 from Eaton Canyon, San Gabriel Mountains. *Pellaea mucronata* is also well illustrated by a photograph in Christ's work on the geography of Polypodiaceae.[11] To my knowledge there has never heretofore been published a photograph of *Pellaea compacta*.

I concur with Munz and Johnston that between *Pellaea compacta* and *Pellaea mucronata* "the most striking difference is in the arrangement of the pinnules,"[12] giving a wholly different aspect to these ferns in their typical states, as illustrated by *figs. 1 a* and *c*. After the examination of more than two hundred sheets of the two species involved I present Table 1 of *differentiae:*

The habitat and altitudinal distribution of these Pellaeas likewise differ, for whereas *mucronata* favors the semi-shade beneath sclerophyllous shrubs of the foothill chaparral belt, especially the widespread *Adenostoma fasciculatum* association, *compacta* is found in the boulder crevices of open ridges and slopes, often along exposed "divides." And whereas *mucronata* uncommonly ascends to the lower portions of the Transition Zone, where it often occupies less xerophytic situations, *compacta* is normally an inhabitant of the upper Transition Zone. Maxon quotes Parish[13] as to the existence of a "geographical hiatus between the two species in which no *Pellaea* occurs," but I have seen collections of the two species altitudinally only 1200 feet apart and it seems unlikely that the two ferns do not meet. It is true that the two Pellaeas do not commonly merge and that there is a "fairly distinct geographic range."[14] It is from such meeting-grounds as San Antonio Can-

[10] Dobbs Camp, on U. S. Geol. Survey San Gorgonio Quadrangle, ed. 1902, reprint 1927. Precisely a delapidated cabin at a cienaga on Falls Creek.

[11] CHRIST, H. *Die Geographie der Farne*, p. 158, fig. 72, 1910.

[12] Amer. Fern. Jour. 12: 107 1922

[13] Amer. Fern Jour 8: 90 1918.

[14] Amer. Fern Jour. 12: 107. 1922.

TABLE 1.—DISTINGUISHING CHARACTERS OF PELLAEA MUCRONATA AND P. COMPACTA

	P. mucronata	*P. compacta*
Attitude of pinnae "in nature"	Ranked in 2 planes to form a trough with a basal right angle	Curving toward each other to form an imperfect cylinder
Attitude of pinnae on herbarium sheet	Usually obliquely ascending (whereas widely spreading in the field)	Secundly superimposed as any cylinder would appear if flattened (see *fig 1, a*)
Length of stipe	Stipe as long as the blade or less	Stipe always longer than the blade (to twice as long)
Spacing of pinnae	Pinnae distant their width	Pinnae all contiguous to pairs above and below
Division of pinnae	Pinnae always partly bipinnate (i.e. pinna divisions near rachis trifid)	Pinnae strictly pinnate (i e, pinna divisions always simple)
Pinnule[a] orientation	Pinnule when unrolled (in nature by drenching rains, in laboratory by boiling) never overlapping adjacent pinnules	Pinnule when unrolled (never under *normal* conditions in nature, in laboratory by boiling) closely overlapping each adjacent pinnule
Pinnule gross morphology	Pinnule, though strongly revolute, not strictly conduplicate but more nearly terete and not at all falcate	"Fertile pinnules . . broadly revolute, often conduplicate and falcate with age." A false intruded suture and characteristic shape give an *Astragalus*-pod aspect to the pinnule (under binocular)
Duration of fronds	Pinnules deciduous, to leave naked spinose pinna rachises	Pinnules persistent, last year's weathered fronds (stone gray color) intact among fronds (gray green) of the season
Dry season condition	Pinna segments appear as pendent bullate sacs from filiform wiry rachises, thus wholly unlike divaricate aspect of wet season	Pinna segments appear as equally ranked members on either side of rachises; unaltered in position throughout the year

[a] Pinnule here taken as the ultimate segment of any fern pinna

yon, San Gabriel Mountains, the place of the above observation, that the troublesome outlying variants arise.

The intermediate (better simply "atypical") states of these two species are due, I believe from field observation, to ecologic (soil or climate or both) factors which may affect either species, occurring chiefly along the margins of their vertical ranges, as when *mucronata* interfingers upwards into the lower Transition Zone. Plants of *Pellaea mucronata* near its upper altitudinal limits may have much reduced pinnules, and these abundant and crowded

—not at all like the common foothill fern in aspect—which comes close to the outlying forms of *compacta* as that species reaches its lower limits. *Fosberg* 8497, San Antonio Canyon, 4500 feet, represents this phase.

On the other hand when *Pellaea compacta* grows in partial shade under pines it may assume the habit of *P. mucronata* in bearing the pinnae divaricately, in the manner of the Arizonan *Pellaea Wrightiana*. This condition is illustrated by *Johnston* 1593, San Antonio Canyon, San Gabriel Mountains, at 5750 feet—about the lower altitudinal limit for *compacta!*—and a likely zone of flux. Here the aspect of *compacta* is quite unlike plants at higher altitudes in the same range. Furthermore, when this species grows in deep north-facing crevices of boulders the pinnae may assume more widely atypical asplenioid forms (*fig. 1, b*) with a few plane rounded pinnules. Growing at the same station, however, at Big Cienaga above Crystal Lake, San Gabriel Mountains (at 6500 feet—here the zone of flux because of the ascent of the Sonoran elements immediately below to raise the whole zonation), are plants of *compacta* (*Ewan* 2703) with divaricate pinnae and of open habit, nearly plane, and only slightly glaucous, whereas typical *compacta* is often distinctly glaucous. Still other plants from this station (*Ewan* 2702), growing in the full sun, match the Lemmon collection above cited from the San Bernardino Mountains in all characters. It is such a typical collection (*Fosberg & Ewan* 4891—though not the Big Cienaga collection referred to above) that is illustrated by *fig. 1, a*. Careful search will then disclose what might be taken as negative evidence for concluding that *Pellaea compacta* is a valid species, but there appears to me to be yet another justified conclusion and disposition.

The systematic relationship in these ferns introduces a principle in the treatment of "unstable species" that, as a working idea, merits consideration. Both *Pellaea mucronata*, conceivably the parent species, and *Pellaea compacta*, the derived species resulting from isolation, in part, and its multiplex resulting factors, are very susceptible to an abnormal environment, with consequent morphological changes away from those characters exhibited by plants of typical habitats. Especially does this reaction occur when the two species approach their altitudinal limits. Irrespective of such uncertain forms as may be found, not at once referable to either species but always peripheral in distribution and numerically few among the species as a whole, a sound working basis is to maintain the limits, when well-defined, as distinct species. Perhaps a parent species and such a limital one may represent a confluent unit, were all the intercalary states known. Nevertheless the recognition of such limital species awaits the day, perhaps decades distant, when a comprehensive knowledge from several correlated fields of study will relate the data presented by new collections in the then better understood mosaic of life forms among plants. The chief disadvantage with the practice of relating minor or questionable limital forms to another long-known species on present incomplete evidence is the fact that such a practice

hides away these plants from the critical observation which might easily be given them were they maintained by botanists on "trial grounds." A recommended practice for the consideration of such uncertain (published) forms in manuals and floras is that in favor among many botanists in giving a characterization (preferably quite full, if not verbatim, from the original description) of such forms, without keying them, as a subhead near the most closely related keyed species.

Therefore, when a plant exhibits a clear set of morphological characters under optimum growing conditions for that species and these characters recur among plants found in similar floristic areas, I favor the recognition of such plants (the "extremes" of some botanists) as species. Many such species may be found commonly to terminate a phylogenetic line, recently budding from the parent species, and therefore will be areally limited. The dubious forms that occur between such species would be then considered taxonomically as individuals, at the same time pointing out their avowed differences and affinities and relating them when practicable to the species which they most nearly approach in the sum total of their characters. This treatment, as species, of what have often been considered as "extremes" necessitates the clear definition of such a plant group, repeating an appreciable number of times the characters present over several floristically related stations.[15] Allowing for local or individual genetic variation the majority of the "intermediates" will be found, I believe, to represent plants in active evolution on the margins of their normal ranges, immigrants into new territory.

O. F. Cook's simile in elucidating the species problem is, among the verbiage extant on that topic, a happy one. "The categories of the biologist are artificial like those of the geographer, but not more so. Geographers do not agree in the grouping of the archipelagoes of the Pacific Ocean, but this is not considered a reason for denying that islands exist or that some islands are close together and others far apart. Species are biological islands, in a sea of non-existence."[16] Awaiting the results of studies by the experimental grower, the geneticist, ecologist, and student of nutrition, the systematic botanist holds a probationary attitude toward the lesser known plant forms in an attempt to differentiate between specific units and those marginal states which approach the better known species in one or several characters, meanwhile being in accord with the view that the ultimate "only way to solve taxonomical difficulties with polymorphic species goes along lines of experimental research."[17]

[15] For "narrow endemics" 3 or 4 stations would suffice, if these were of the same floristic subarea populated by identical or closely related species at the separate stations.

[16] Cook, O. F. *Existence of species* Jour. Hered 5: 158. 1914.

[17] Goddijn, W. A. *On the species conception in relation to taxonomy and genetics.* Blumea 1: 81. 1934.

SUMMARY

Pellaea compacta (Davenp.) Maxon is believed to have been first collected on the slopes of Mt. San Bernardino, where it grows in fair abundance, though not definitely so stated in Davenport's original description of the fern.

Pellaea compacta, confined to the higher mountains of southern California, morphologically well-defined in its typical state but undergoing wide variation under abnormal environments, is considered specifically distinct from the geographically widespread *Pellaea mucronata*.

The so-called "intermediates" of the two species are found to occur invariably along the margins of their vertical ranges, being absent from *within* the range of typical plants of either species. These outlying forms are generally atypical in only one or two characters which may be understood from field observation to be of edaphic or climatic origin.

Well-defined limital forms (what have often been tagged "extremes") of generally accepted species, sharing with the plants of several floristically related localities definite morphological characters, are recommended to be treated as species.

Atypical forms may be best considered as "near" or "towards" either species according to the sum total of their characters, with a clear statement of their aberrant morphological nature.

BOTANY.—*New species of* Bomarea *from the Andes.*[1] E. P. Killip, U. S. National Museum.

Bomarea, a genus of Amaryllidaceae, contains some of the most showy plants of the South American mountains. The brilliant flowers, usually red and yellow, are often massed in clusters of 50 or more, and present a striking appearance against the dark green foliage of the forest. Though most of the species are high-climbing vines, some inhabit the high mountain plateaus, and these generally are low erect plants, with stiff narrow leaves.

As a member of expeditions to Colombia and Peru I have made a special study of *Bomarea*, and am preparing a revision of the genus. Since this can not be published at present, and the names of several new species are used in a forthcoming article in The National Horticultural Magazine, I am describing herewith eleven as new, most of these based upon material in the herbaria of the Royal Botanic Gardens, Kew, the Muséum National d'Histoire Naturelle, Paris, and the Botanisches Museum, Berlin. To the directors of these institutions I wish to express my appreciation of their many courtesies. Photo-

[1] Published by permission of the Secretary of the Smithsonian Institution. Received June 4, 1935.

graphs, and in some cases fragments of the types, are deposited in the U. S. National Herbarium.

The most comprehensive monographs of Amaryllidaceae are those of Herbert,[2] Kunth,[3] and Baker.[4] In treating *Bomarea* Baker recognized as subgenera two small groups of species, which both Herbert and Kunth had placed in separate genera, these subgenera being designated by Baker as *Wichaurea* and *Sphaerine*. In classifying the true Bomareas Baker followed his predecessors in recognizing four main groups, as follows:

Umbel rays simple.
  Petals and sepals subequal (*Multiflorae*).
  Petals much longer than the sepals (*Caldasianae*).
Umbel rays forked.
  Petals and sepals subequal (*Edules*).
  Petals much longer than the sepals (*Vitellinae*).

I have given names to these groups as above, in order to refer to them more readily. The arrangement is not wholly satisfactory, and perhaps does not express the actual relationships of the species, but until more herbarium material, expecially more fruiting material, is available, it will suffice.

Bomarea (*Wichaurea*) **campanuliflora** Killip, sp. nov.

Caulis strictus (?), parte suprema recurvata, glaber; folia linearia, revoluta, rigida, subtus rufo-pilosula; radii 4, glabri, 1–2-furcati; ovarium ± superius, glabrum; sepala late ovata, rubra; petala oblanceolato-unguiculata, quam sepala longiora, rubra, apice viridi.

Stem apparently erect, recurved toward apex, about 3 mm. in diameter, leafy except toward base, glabrous; leaves linear, 3 to 9 cm. long, decreasing toward apex, 3 to 6 mm wide (the upper the broader), crowded, strongly revolute, rigid, sessile, rufo-pilosulous beneath; bracts similar to the leaves, slightly involute; umbel rays 4, about 4.5 cm. long, glabrous, once or twice forked, bracteolate, the lowest bractlets up to 2.5 cm. long; ovary broadly turbinate-campanulate, glabrous, partly superior; sepals broadly ovate, 2 to 2.5 cm. long, 1 to 1.5 cm. wide, acuminate, glabrous, red; petals oblanceolate-unguiculate, 2.5 to 3 cm. long, the blade longer than the claw, 1 to 1.3 cm. wide, acute, red, green-tipped; stamens subequal to the petals, the anthers oblong, about 3.5 mm. long; styles exserted, the stigma shallowly trifid.

Type in the herbarium of the Botanisches Museum, Berlin, collected at Quebrada de Toipata (?), Department of Puno, Peru, August, 1864, by A. Raimondi (no. 10229).

The general appearance of the inflorescence suggests *B. grandis*, but because of the proportionately broad sepals and the strongly involute leaves it is evidently a distinct species.

[2] Herbert, W Amaryllidaceae 1837.
[3] Kunth, C. S. Enum. Pl. 5: 467–850. 1847
[4] Baker, J. G. Handbook of the Amaryllideae. 1888

Bomarea (*Wichaurea*) **zosteraefolia** Killip, sp. nov.

Ubique glaberrima; caulis strictus, rigidus, ad apicem recurvatus, foliosissimus; folia linearia, subrevoluta, membranacea; radii ca. 6, prope medium furcati; *ovarium turbinatum; segmenta perianthii* subaequalia, sepalis lineari-oblongis, subacutis, petalis oblongo-spathulatis, flavescentibus (?), purpureo-maculatis.

Plant erect, rigid, 30 or more cm. high, glabrous throughout; stem subterete, 2.5 to 4 mm. in diameter, recurved toward apex, densely leafy, the leaves reduced or probably wanting toward base; leaves linear, 4 to 12 cm. long, 2 to 3 mm. wide (diminishing from middle of stem to apex), acute, sessile, slightly revolute, membranous, green on both surfaces, divaricate; bracts similar to the leaves; umbel rays about 6, 2.5 to 3 cm. long, slender, forked near middle, the bractlets similar to the leaves, 1.5 to 2 cm. long; ovary turbinate, sulcate; sepals linear-oblong, about 2.5 cm long and 6 mm. wide, subacute, red, green-tipped; petals oblong-spatulate, subequal to the sepals, yellowish(?), green-tinged and purple-maculate at apex; stamens subequal to the perianth, the anthers oblong, about 2.5 mm. long; style slightly exserted, trifid.

Type in the herbarium of the Muséum National d'Histoire Naturelle, Paris, collected in the Department of Ancachs, Peru, by Martinet (no. 742).

The longer spreading leaves, which are of a much thinner texture, scarcely revolute, and glabrous beneath, and the diffuse inflorescence are characters by which this may be distinquished from *B. dulcis*, a related species.

Bomarea uniflora (Mathews) Killip

Alstroemeria uniflora Mathews; Herb. Amaryll. 104. 1837, as synonym.
Wichaurea dulcis uniflora M. Roemer, Fam. Nat. Syn. **4**: 278. 1847.

Bomarea (*Sphaerine*) **incana** Killip, sp. nov.

Caulis strictus, teres, tener, glaber; folia pauca, ovato-oblonga, membranacea, subtus pilis albidis vel brunnescentibus dense hirsuto-tomentosa; radii 1 vel 2, ad medium furcati vel subfurcati, bracteolis foliis similibus; ovarium auguste obconicum, rufo-tomentellum; segmenta perianthii aequalia, sepalis oblongis, petalis oblanceolato-spathulatis, flavis, apice viridi, purpureo-punctatis.

Stem erect, 50 to 60 cm. high, slender, terete, glabrous, leafless in lower half, few-leaved in upper half; leaves sessile or subsessile, ovate-oblong, 4–6 cm long, 1.2 to 2.3 cm. wide, acute at apex, rounded at base, membranous, glabrous above, densely hirsute-tomentose beneath with white or light brown hairs, the hairs chiefly borne on the side of the veins, divaricate but closely appressed to the blade; bracts 2, similar and equal to the leaves; umbel 1 or 2-rayed, the rays 5 to 12 cm. long, forked near middle (or one fork scarcely developed), bracteolate at fork, the bractlets similar to the leaves, 1.5 to 3 cm. long; ovary narrowly obconic, densely rufo-tomentellous; perianth segments equal, 2 to 2.3 cm. long; sepals oblong, 6 to 9 mm. wide, red and puberulous without, pale and glabrous within; petals oblanceolate-spatulate, the blade 6 to 7 mm. wide, yellow, green-tinged apically and purple-spotted; stamens subequal to perianth; stigma trifid.

Type in the herbarium of the Jardín Botánico, Madrid, collected at the Alto del Cóndor, between Ibagué and El Nevado del Tolima, Department of Tolima, Colombia, altitude 3,500 meters (Central Cordillera), May 17,

1932, by J. Cuatrecasas (no. 2224). Represented also by *Goudot* 4 and *Dawe* 807, from the same general region.

This is nearest *B. holtonii*, also a Colombian species, which has 7 or 8 primary rays, a quadrangular stem, and sparingly pilosulous leaves.

Bomarea (*Eubomarea* § *Caldasianae*) **vegasana** Killip, sp. nov.

Caulis volubilis, angulatus, rufo-tomentulosus; folia lanceolata, subcoriacea, subtus minute puberula; radii ca. 35, simplices, ebracteolati, cum ovario conico viscoso-tomentosi; sepala lineari-oblonga; petala cuneato-unguiculata, sepalis longiora, lutea.

Herbaceous vine; stem rather stout, 4 to 6 mm. wide, angular, densely rufo-tomentulous; petioles 6 to 8 mm. long, winged; leaves lanceolate, 8 to 12 cm. long, 2 to 2.5 cm. wide, acuminate at apex, abruptly narrowed at base, subcoriaceous, glabrous above, minutely puberulent beneath; bracts of 2 forms, the outer oblong-lanceolate, 3 to 5 cm. long, 8 to 10 mm. wide, reflexed, the inner linear, 1 to 1.5 cm. long, 3 mm. wide, suberect; umbel simple, about 35-rayed, the rays 4 to 5 cm. long, ebracteolate, viscous-tomentose; sepals linear-oblong, about 3 cm. long, 6 mm. wide, red, puberulent without; petals cuneate-unguiculate, about 4 cm. long, the blade subequal to the claw, yellow, not spotted; stamens 3 to 3.5 cm. long, unequal, the anthers ovate-oblong, 6 to 7 mm. long.

Type in the U. S. National Herbarium, no. 1,351,609, collected in mountains east of Las Vegas, Department of Santander, Colombia, altitude 3,300 to 3,400 meters (Eastern Cordillera), December 21, 1926, by E. P. Killip and A. C. Smith (no. 15784). Represented also by *Killip & Smith* 15587, from the same locality.

This closely resembles *B. andreana*, but the petals are definitely unspotted and the leaves, which are of thicker texture, are minutely puberulent beneath.

Bomarea (*Eubomarea* § *Edules*) **subsessilis** Killip, sp. nov.

Caulis substrictus et subflexuosus, tenerrimus, glaber; folia oblanceolata vel elliptica, ad basin attenuata, subsessilia, subtus breviter crispato-pilosa; bracteae 2; radii 2–4, tenerrimi, glabri, 1–2-furcati, bracteolis parvis; ovarium late turbinatum; segmenta perianthii subaequalia, apice viridi, sepalis oblongo-spathulatis roseis, petalis spathulatis-unguiculatis, flavidulis.

Stem 35 to 50 cm. long, suberect or at least very slightly voluble, subflexuose, angulate, slender, glabrous; leaves oblanceolate or elliptic, 2.5 to 5.5 cm. long, 0.7 to 1.8 cm. wide, acute at apex, tapering to base without a well-defined petiole, resupinate, divaricate or somewhat ascending, membranous, glabrous above, short-crispate-pilose beneath; bracts 2, ovate-oblong, 7 to 13 mm. long, 3 to 5 mm. wide; umbel 2 to 4-rayed, the rays slender, 3.5 to 4.5 cm. long, glabrous, once or twice forked, bearing at the forks an ovate-oblong or linear-oblong, reddish bractlet 7 to 10 mm. long; ovary broadly turbinate, 6 to 8 mm. long, up to 6.5 mm. in diameter at apex, about one-fifth superior, longitudinally sulcate, glabrous, black; sepals oblong-spatulate, 1.2 to 1.6 cm. long, 5 to 7 mm. wide, obtuse, reddish pink, green at apex; petals spatulate-unguiculate, subequal to sepals in length and breadth, pale yellow, green-tinged; stamens shorter than the perianth, unequal, the anthers orbicular-oblong, about 1.5 mm. long; pistil subequal to stamens, the stigma trifid.

Type in the herbarium of the Botanisches Museum, Berlin, collected near Cochabamba, Department of Cochabamba, Bolivia, 3,400 meters altitude, February 27, 1928, by C. Troll (no. 1630) Represented also by *Bang* 2039, from the same locality.

This is one of several species that are clearly distinct in themselves but which, because of our imperfect knowledge of the lines of demarcation of the subgenera, are difficult to assign systematically. The suberect habit of the plant, the absence of a definite petiole, and the partly superior ovary suggest the subgenus *Wichaurea*. In other respects it seems more closely allied with the small-flowered species of *Eubomarea* § *Edules*.

Bomarea (*Eubomarea* § *Edules*) **campylophylla** Killip, sp. nov.

Caulis volubilis, teres, glaber; folia lineari-lanceolata, subfalcata, conspicue nervosa, glabra; bracteae foliis similes, falcatae; radii 5 vel 6, subglabri, supra furcati, biflori, 1–2-bracteolati; ovarium cylindrico-turbinatum; segmenta perianthii subaequalia, sepalis oblongis, petalis spathulatis, quam sepalis augustioribus, luteis, purpureo-maculatis, apice viridi.

Herbaceous vine; stem terete, 2 to 3 mm. in diameter, glabrous; petioles up to 6 mm. long, crispate-margined; leaves linear-lanceolate, 6 to 12 cm. long, 1 to 1.5 cm wide, subfalcate, acuminate at apex, rounded at base, strongly and closely nerved, glabrous, concolorous; bracts similar to the leaves, 7 to 10 cm. long, 5 to 8 mm. wide, falcate; umbel 5 or 6-rayed, the rays 10 to 15 cm. long, divaricate or arcuate-ascending, rufo-puberulent and viscid at apex, otherwise glabrous, forked near apex, 2-flowered, bracteolate at fork and sometimes just below fork, the lower bractlets similar to the bracts, 4 to 5 cm. long; ovary cylindric-turbinate, densely rufo-tomentose; perianth segments subequal, about 1.5 cm long, the sepals oblong, 7 to 8 mm. wide, red and rufo-puberulent without, yellow within, green at apex, the petals spatulate, slightly narrower than the sepals, yellow, purple-maculate, green at apex; stamens shorter than the perianth, the anthers ovate-oblong, about 2.5 mm long; style trifid.

Type in the U. S. National Herbarium, no. 1,192,850, collected at Villcabamba, Department of Huánuco, Peru, altitude about 1,800 meters, July 17 to 26, 1923, by J F. Macbride (no. 4961). Duplicate at the Field Museum.

This is allied to *B. salsilla*, *B. subsessilis*, and *B. nematocaulon*, species of *Eubomarea* § *Edules* with very small flowers, the perianth being not more than 1.5 cm. long. There are many points of difference between these three species and *B. campylophylla*.

Bomarea pennellii Killip

Bomarea longipes Kränzl. Bot. Jahrb. Engler 40: 234. 1908, not Baker, 1882.

In assigning a specific name to this Colombian plant Kränzlin overlooked the earlier use of *longipes* for a wholly different plant from Ecuador. It is appropriate that the species be named for Dr. F. W. Pennell, whose extensive explorations in Colombia have done much to make known the plant life of that country.

Bomarea (*Eubomarea* § *Edules*) **trichophylla** Killip, sp. nov.

Caulis volubilis, glaber; folia ovato-lanceolata, subtus in nervis dense pilosa; radii 4–7, glabri, supra medium 2–3-furcati, bracteolis oblongo-lanceolatis vel lineari-lanceolatis; ovarium late turbinatum, glabrum; segmenta perianthii aequalia, apice viridi, sepalis obovato-oblongis, extra roseis, intus flavidulis, petalis oblongo-spathulatis, luteis; capsula turbinata, aurantiaca.

Herbaceous vine; stem rather slender, 2 to 3 mm. thick, sulcate, glabrous; petioles 1 to 1.5 cm. long, narrowly winged; leaves ovate-lanceolate, 7 to 11 cm. long, 2 to 3.5 cm. wide, acuminate at apex, rounded at base, membranous, glabrous above, densely pilose on nerves beneath with divaricate whitish hairs; bracts leaflike, persistent, varying in size in individual plants from 5 to 7 cm. long and 1 to 2.5 cm wide, petiolate, pilose on nerves beneath; umbel rays 4 to 7, 15 to 25 cm. long, glabrous, twice or thrice-forked above middle, bracteolate at the forks, the lowermost bractlets oblong-lanceolate, 1 to 1.5 cm. long, 2 mm. wide; ovary broadly turbinate, glabrous; perianth segments equal, 2 to 2.5 cm. long, the sepals obovate-oblong, 1 to 1.2 cm. wide, pinkish without, yellowish or cream-color within, green-tinged at apex; petals oblong-spatulate, 8 to 11 mm. wide, yellow, green at apex, purple-dotted within; stamens equal, slightly shorter than the perianth, the anthers ovate, 4 to 5 mm. long, 2 mm wide; fruit turbinate, about 2 cm. in diameter, orange.

Type in the U. S. National Herbarium, no 1,574,158, collected near Vetas, Department of Santander, Colombia, altitude 3,100 to 3,250 meters (Eastern Cordillera), January 19, 1927, by E. P. Killip and A. C. Smith (no. 17881). Represented also by several other Killip and Smith collections from the departments of Santander and Norte de Santander.

This species most nearly resembles *B. moritziana*, but differs in having glabrous rays and ovaries, larger flowers, and obovate-oblong sepals.

Bomarea (*Eubomarea* § *Edules*) **perlongipes** Killip, sp. nov.

Caulis et folia desunt; bracteae late ovato-lanceolatae, subtus dense hirsutae; radii 10 (vel ad 20?), perlongi, crassi, erecti vel adscendentes, glabri, supra medium bifurcati, bracteolis ovato-lanceolatis, infimis magnis; ovarium cylindrico-turbinatum, glabrum; segmenta perianthii aequalia, sepalis obovato-oblongis, roseis, petalis oblongo-spathulatis, luteis, brunneo-maculatis

Stem and leaves wanting; bracts broadly ovate-lanceolate or oblong-lanceolate, 7 to 11 cm. long, 2 to 5 cm. wide, abruptly acuminate at apex, subacute at base, glabrous above, densely hirsute beneath; umbel rays 10 (up to 20?), about 40 cm long, stout, erect or ascending, glabrous, twice-branched above middle, bracteolate at forks, the bractlets ovate-lanceolate, acuminate, glabrous above, sparingly hirtellous and puberulent beneath, the lowermost 6 to 7 cm. long, 2 to 2.5 cm. wide, the upper decreasing in size; ovary cylindric-turbinate, glabrous; perianth segments equal, 4 to 5.5 cm. long, the sepals obovate-oblong, 7 to 8 mm. wide, callous-thickened at apex, rose, the petals oblong-spatulate, 1.2 to 1.5 cm. wide, yellow, brown-spotted; stamens 3 to 3.5 cm. long.

Type in the herbarium of the Muséum National d'Histoire Naturelle, Paris, collected in the Province of Ocaña, Department of Norte de Santander, Colombia, altitude about 1,525 meters, July (1846–1852), by L. Schlim (no. 718).

The specimen at hand has been cut off just at the base of the umbel, three bracts being attached. The stem and leaves may have been mounted on another sheet or perhaps not distributed to the Paris herbarium. Schlim's 455, consisting of two leaves and a short stem only, may represent this species; it was also collected in the Province of Ocaña, but at a much higher altitude. The stem is rather slender and glabrous, and the leaves are broadly ovate (16 to 17 cm. long, 7.5 to 8 cm. wide) and bear beneath an indument very similar to that of the bracts of *B. perlongipes.*

Among the large-flowered species of this group *B. perlongipes* is readily recognized by the prominent bractlets.

Bomarea (*Eubomarea* § *Vitellinae*) **schultzei** Killip, sp. nov.

Caulis volubilis, crassus, glaber; folia late lanceolata, membranacea, subtus hirsuto-tomentosa; radii ca. 20, teneri, bifurcati, bracteolis ovatis; ovarium turbinatum, rufo-tomentulosum; sepala late ovata, roseo-rubra; petala cuneato-unguiculata, sepalis multo longiora, viridia, ad basin roseo-rubra.

Herbaceous vine, up to 4 meters long; stem stout, 4 to 5 mm. wide, subangular, glabrous; petioles up to 2 cm. long, winged; leaves broadly lanceolate, 12 to 14 cm. long, 4.5 to 5 cm. wide, caudate-acuminate at apex, rounded at base, abruptly tapering to petiole, thin-membranous, glabrous above, sparingly to densely hirsute-tomentose beneath, the nerves scarcely elevated above; bracts leaflike, lanceolate, up to 8 cm. long and 2 cm. wide; umbel about 20-rayed, the rays about 25 cm long, glabrous, pilosulous toward apex, fairly slender, twice-branched, bracteolate at the forks, the bractlets ovate, acuminate, the lowermost up to 2.5 cm. long and 1.1 cm. wide; ovary turbinate, sulcate, rufo-tomentulous; perianth segments very unequal, the sepals broadly ovate, 2.5 to 3 cm. long, 1.2 to 1.4 cm. wide, obtuse, glabrescent, bright rose-red, the petals cuneate-unguiculate, 3.2 to 3 7 cm long, the blade 1.4 to 1 8 cm. wide, bright green, spotted with brown, the claw slightly shorter than the blade, rose-carmine; stamens unequal, 3 about 2.7 cm. long, 3 about 8 mm longer, the anthers ovate-oblong, about 4 mm long; pistil about 1 5 cm. long.

Type in the herbarium of the Botanisches Museum, Berlin, collected at Aguadita, Department of Cundinamarca, Colombia, altitude 1,750 meters (Eastern Cordillera), April 12, 1925, by Arnold Schultze (no. 213).

This handsome species belongs to the small section with unequal perianth segments and forked umbel rays. It is readily distinguished from *B. vitellina*, its nearest relative, by the much broader sepals, the pubescence on the under side of the leaves, and the coloring of the petals.

Bomarea (*Eubomarea* § *Vitellinae*) **hazeni** Killip, sp nov.

Caulis volubilis, glaber; folia ovato-lanceolata, subtus in nervis pilosa; radii 5–9, cum ovario viscoso-tumentosi, 1–3-furcati, bracteolati; segmenta perianthii inaequalia, sepalis oblanceolatis, extus pubescentibus, petalis cuneato-unguiculatis, quam sepalis longioribus, non punctatis.

Herbaceous vine; stem stout, 3 to 5 mm. in diameter, subterete, glabrous, sparingly pilosulous at extremity; petioles up to 1 cm. long, narrowly winged, densely pilosulous on one side; leaves ovate-lanceolate, 6 to 11 cm. long, 2

to 4 cm. wide, caudate-acuminate at apex, rounded at base, subcoriaceous, 15 to 20-nerved (nerves elevated beneath), glabrous and lustrous above, pilose on nerves beneath; bracts lanceolate, up to 5 cm. long, reflexed; umbel 5 to 9-rayed, the rays 7 to 15 cm. long, densely viscous-tomentose, 1 to 3 times forked, bracteolate at the forks, the bractlets lanceolate, about 1 cm. long; ovary turbinate, viscous-tomentose; perianth segments unequal, the sepals oblanceolate, 1 5 to 2.5 cm. long, 7 to 9 mm. wide, pubescent and red without, yellow within, the petals cuneate-unguiculate, about 5 mm longer than the sepals, the blade 1 to 1.5 cm. wide, truncate, deep yellow, unspotted; stamens unequal, 3 slightly longer than the other 3, the anthers oblong, about 4 to 5 mm. long; pistil slightly shorter than the stamens.

Type in the U S. National Herbarium, no. 1,143,705, collected at Magaña, Quindío Trail, Department of Caldas, Colombia, altitude 3,400 meters (Central Cordillera), August 2, 1922, by E. P. Killip and T. E. Hazen (no. 9174).

Additional specimens examined, all from Colombia: Cundinamarca: *Triana* 525. Tolima: *Killip and Hazen* 9492, 9500; *Pennell* 2978. Caldas: *Pennell and Hazen* 10085.

The general shape of the perianth segments and their coloring suggest species of *Caldasianae*, but the rays are forked, the secondary flowers being well developed. The species is more closely related to *B. vitellina*, which has much larger flowers and glabrous leaves.

Bomarea (*Eubomarea* § *Vitellinae*) **inaequalis** Killip, sp. nov.

Caulis volubilis, crassus, glaber; folia oblongo-lanceolata, subcoriacea, subtus in nervis dense pilosa; radii ca. 8, teneri, elongati, pilosuli, bifurcati, bracteolis ovato-lanceolatis; ovarium turbinatum, viscoso-tomentosum; segmenta perianthii valde inaequalia, sepalis obovatis, glaberrimis, petalis quam sepalis longioribus, cuneato-unguiculatis, luteis, dense purpureo-punctatis

Herbaceous vine; stem stout, about 5 mm wide, subangular, glabrous; petioles 1 to 1.2 cm long, narrowly winged; leaves oblong-lanceolate, 15 to 18 cm long, 2.5 to 3 cm. wide, acuminate at apex, rounded at base, subcoriaceous, glabrous above, densely pilose on nerves beneath; bracts ovate-lanceolate, about 4 cm. long and 1.3 cm. wide, acuminate; umbel rays about 8, slender, 12 to 15 cm. long, sparingly pilosulous below, densely so above, twice branched above middle, bracteolate at forks, the bractlets ovate, the lowermost about 1 cm. long; ovary turbinate, viscous-tomentose; perianth segments very unequal, the sepals obovate, about 1.5 cm long and 6 mm. wide, glabrous, red (?), the petals cuneate-unguiculate, 2 to 2 3 cm. long, the blade about 1 cm. wide, yellow, conspicuously spotted with purple; stamens unequal, 3 about as long as the petals, 3 shorter, the anthers oblong, about 4 mm long.

Type in the herbarium of the Botanisches Museum, Berlin, collected at Río Frío, Department of Santander, Colombia, July 3, 1878, by W. Kalbreyer (no. 760). Duplicate at Kew

The petals of *B. inaequalis* are very markedly longer than the sepals and the umbel rays are forked; in this small group it comes nearest *B. hazeni*, which has pubescent sepals, small ovato-lanceolate leaves, and very obscurely marked petals.

PALEOBOTANY.—*A Douglas fir cone from the Miocene of southeastern Oregon.*[1] CHESTER A. ARNOLD, University of Michigan. (Communicated by E. C. CASE.)

Occasional reference has been made in the literature to remains of *Pseudotsuga* in the Tertiary and Quarternary deposits of western North America but the material is seldom abundant or well preserved. A recently discovered impression of a well preserved cone which shows not only the scales but also the exserted bracts is considered worthy of mention.

The cone under consideration (fig. 1) was discovered by Mr. Percy Train in 1932 while engaged in excavating plant fossils in the Trout

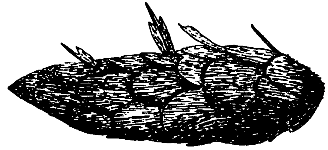

FIG 1.—*Pseudotsuga taxifolioidea* sp. nov Natural size.

Creek diatomite in the southeastern part of Harney County, Oregon. All the organic matter of the cone had disappeared, leaving only the somewhat flattened cavity, on the inner surface of which imprints of the cone scales can be seen. A fortunate break had split the specimen exactly in half so that both sides of the cavity are retained. Extending laterally from between the closely appressed cone scales are several trident-shaped bracts, characteristic of *Pseudotsuga*. One bract is nearly complete while only portions of others are clearly visible. These bracts render generic identification of the fossil positive.

Pseudotsuga taxifolioidea Arnold, sp. nov.

The cone is 2.5 cm wide and slightly over 8 cm. long. It is long-oval, rounded at the base, slightly broadest below the middle and rather tapering above. The scales are broad and rounded apically. They are tightly appressed, characteristic of Douglas fir cones that have been water soaked. The bracts project outward for a distance of approximately 1.5 cm. beyond the cone scales and are about 0 5 cm. wide.

The similarities between this cone and the cones of Douglas fir, *Pseudotsuga taxifolia*, are close. It is too small for the cone of *P. macrocarpa*, in which the range in length, as given by Jepson (1), Sargent (2), and Sud-

[1] Received May 2, 1935.

worth (3) may be from 10 to 18 cm. Those of *P. taxifolia* may range from 4 to 11 cm. Therefore, the Trout Creek specimen is well within the size limits of the latter species although probably somewhat larger than a cone of average size. The exsertion of the bracts is also indicative of affinity with this species since this feature is often cited as a diagnostic character. The bracts of *P. macrocarpa* protrude but little. There are no points of resemblance between this specimen and *P. japonica*, the Japanese species.

Abundant seeds from the Trout Creek diatomite have been described by MacGinitie as *Pseudotsuga masoni* (4). He also assigns twigs to this species, and it is quite possible that the seeds, twigs and cones in the diatomite all belong to the same species. Identity of these detached organs might also seem more probable as *Pesudotsuga* is not a large genus and the seeds and cones of the different species are distinguishable. Whether or not this is true for the extinct types is unknown although the fossil record does not indicate that the genus was ever a large one. The reason, however, for assigning the Trout Creek specimen to a new species is because erroneous determinations of organs in the detached condition lead to confusion. MacGinitie remarks upon the close resemblance between the seeds he assigns to *P. masoni* and those of living *P. taxifolia*, a resemblance which is indeed close. But whether these seeds belonged to a plant that is really conspecific with *P. taxifolia*, as the living species is defined, is only conjectural, since the fossil record of *Pseudotsuga* is meager. Consequently it is considered advisable to describe this cone as new while at the same time keeping in mind the close resemblance to the living species as well as its intimate association with *P. masoni*. It is felt that in this way less confusion would result if later investigations were to demonstrate that during Miocene times there were other species of *Pseudotsuga* to which these organs might belong. The name *Pseudotsuga taxifolioidea* sp. nov., is therefore proposed for this cone, the specific name indicating its resemblance to the living form. The holotype is No. 17241 of the University of Michigan collection.

Among the heretofore unrecorded species associated with *Pseudotsuga taxifolioidea* in the Trout Creek diatomite the following may be noted.

Acer bendirei Lesq.
Ailanthus sp. fruit (cf. living *A. glandulosa*)
Amelanchier sp. (cf. living *A. alnifolia*)
Castanopsis sp.
Catalpa? sp. (cf. living *C. speciosa*)
Celtis cf. obliquifolia Chaney
Cladrastis sp. nov.

Cornus sp. (cf. living *C. circinata*)
Crataegus sp. (cf. living *C. pinnatifida*)
Equisetum sp. (cf. living *E. hyemale*)
Nymphaeophyllum gen. et sp. nov.
Ostrya oregoniana Chaney (fruit sac)
Peltandra sp. nov.
Polpulus balsamoides Goepp.
Populus sp. (cf. living *P. grandidentata*)

These, along with other species, will be discussed in future publications.

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ZOOLOGY.—*Contributions to Texas herpetology. III. Bullsnakes of the genera* Arizona *and* Pituophis.[1] CHARLES E. BURT, Southwestern College. (Communicated by L. STEJNEGER.)

Four species of bullsnakes of the genera *Arizona* and *Pituophis* are now known to occur in Texas, *P. melanoleucus ruthveni* being here reported from the state for the first time. Distinguishing characters of the species are presented in the following key.

1. Keels present on some or all of the dorsal scales . . . 2
   Dorsal scales smooth.
   Arizona elegans elegans (Kennicott).
2. Normally with not more than one upper labial (4 or 5) bordering eye 3
   Two upper labials (3–4 or 4–5) bordering eye. Southern Texas.
   Pituophis deppei deppei (Duméril and Bibron).
3. Dark dorsal saddles on body and tail more than 56.
   Pituophis sayi sayi (Schlegel).
   Dark dorsal saddles on body and tail 56 or less. Eastern Texas.
   Pituophis melanoleucus ruthveni (Stull).

These four species resemble each other in being large, beneficial, non-poisonous, carnivorous, field-inhabiting forms with many dark blotches or saddles on the back.

Arizona elegans elegans (Kennicott)

This snake has been reported from Texas, west of the 98th meridian (Blanchard, 1925, p. 22). A dead example removed from the road 11

[1] Received May 15, 1934.

miles north of Encino, Brooks County, on April 4, 1931, occurred at a point almost precisely on the 98th meridian. It had 31 scale rows at the middle of the body. The United States National Museum has three Texan specimens of this form. The type (No. 1722) from the Lower Rio Grande Valley is faded but well preserved. Two examples from Bexar County were taken at San Antonio (Hurter Coll., May 19, 1908) and Somerset (A. J. Kirn, Mar. 12, 1926) respectively.

Pituophis deppei deppei (Duméril and Bibron)

This form is typically a native of Mexico, but Stull (1932) has indicated that it ranges northward in Texas as far as San Marcos, Hays County.

Pituophis melanoleucus ruthveni Stull

A bullsnake, secured on May 9 on the road near a plot of grass 5 miles southeast of Zavalla, Angelina County (U.S.N.M. No. 83672), in the sandy cut-over pine barren region of eastern Texas, resembled *sayi* of more western and northern areas so closely that it was presumed to be that form until it was identified in the laboratory. Here it was soon found to have the reduced number of dorsal saddles or blotches assigned to "*P. melanoleucus ruthveni*" by Stull (1929), rather than the higher number specified for the form which was termed "*P. sayi sayi*" in the same publication. This led to the identification of the specimen at hand as *ruthveni* (thus introducing the form into the state of Texas) and to a charting of the characters of the several bullsnakes from the critical region in Texas and Louisiana to see if an implication of continuous and progressive geographical variation might be drawn for these snakes. The following table presents these data:

TABLE 1 —VARIATIONS OF PITUOPHIS IN EASTERN TEXAS AND IN LOUISIANA

Locality	La (type) Rapides Parish	La. (paratype) Rapides Parish	Texas Angelina Co	Texas Ellis Co	Texas Clay Co
Scale formula	31–33–25	31–31–22	31–28–21	31–33 25	31–33–25
Ventrals	219	218	213	223	215
Caudals	59	60	56	62	56
Labials	9-8/15	8/14	9-8/13-14	8/12	9/13
Postoculars	4	3	2 3	3	3
Dorsal saddles on tail	9	?	10	12	12
Dorsal saddles on body	41	?	42	48	54
Total saddles	50	?	52	60	66

Before discussing the taxonomic significance of the above data, attention is called to the geographical position of each of the individuals concerned. The type and paratype of *ruthveni* are from Rapides Parish, central Louisiana, and the additional specimen of *ruthveni* is

from Angelina County, eastern Texas, in a line almost directly west of the type locality. The specimen of *sayi* from Ellis County, Texas, is from a point east of the previously known range of *sayi* and in this way it represents the closest known geographical approach of the range of *sayi* to the range of *ruthveni;* whereas the example of *sayi* from Clay County, Texas, is near the previously known eastern border of the area occupied by *sayi*, but yet far enough north to be considered as more nearly representative of the typical form. Here, then, we find a fine geographical range of specimens arranged in a line from central Louisiana to north-central Texas.

From the standpoint of scutellation, the table reveals no particularly significant differentiation between the eastern and western stocks, even the type specimens of *ruthveni* having the exact scale formula of examples of *sayi* from Ellis and Clay counties, Texas.

But, from the standpoint of the color pattern, with specific reference to the number of dorsal saddles (which seems to be the only significant criterion advanced in the original diagnosis of *ruthveni* for its separation from *sayi*), there is a definite correlation. Originally the gap between *ruthveni* and *sayi* appeared to be wide—perhaps a matter of 15 dorsal saddles as obtained in comparing the extremes in the above table (50 to 66 saddles) but, in parallel with the development in many similar cases, additional specimens from intervening areas here greatly reduce the known differentiation between the two populations. Thus, we find that the known number of dorsal saddles is raised two in *ruthveni* by the specimen from eastern Texas (52 saddles) and lowered six in *sayi* through the example from Ellis County, central Texas (60 saddles); and the fact that this leaves a gap of only seven saddles between the diverging extremes concerned bears taxonomic significance in making it obvious that *ruthveni* and *sayi* must ultimately be ranked as subspecies[2] of each other and that therefore the taxonomy indicated in the original description of *ruthveni* must be changed in some way.[3] Published data of intergradation between *ruthveni* and a subspecies of *melanoleucus* have not been advanced, although Mr. Percy Viosca, Jr., has informed me that certain eastern Louisiana specimens that he has seen are approximately intermediate

[2] Speaking generally from what is known of the variation of other herpetological forms in this region (particularly those of the genera *Lampropeltis*, *Masticophis*, *Tantilla* and *Cnemidophorus*), it seems logical to assume that the collecting of additional bullsnakes in eastern and central Texas will enable us to bring these significantly approaching extremes of variation in two subspecies of *Pituophis* closer and closer together, thus ever more definitely revealing the somewhat superficially concealed intergradation between them.

[3] This view has been expressed by Dr. Frank N. Blanchard in a written communication.

between *ruthveni* and *lodingi*. If this is revealed and if *lodingi* in its turn intergrades with the true *melanoleucus* that occurs still further east, a whole chain of geographical races or subspecies of the long known *melanoleucus* will be placed in evidence. Such action is not unlikely. The ultimate series may include the following forms: *melanoleucus, mugitus* (southern Florida), *lodingi* (Alabama and probably Mississippi), *ruthveni, sayi* and *affinis* (west Texas). Pending the appearance of data contained in Dr. Stull's forthcoming revision of the genus *Pituophis*, and also in anticipation of further field work in eastern Texas and in Louisiana, the present writer feels that nothing is to be gained by making a nomenclatorial change here in the proposed status of either *ruthveni* or *sayi*.

Pituophis sayi sayi (Schlegel)

Several representatives of this form were collected near grassy areas from whence they had wandered to cement pavement to be killed by passing automobiles. Data pertaining to some of these individuals have been presented and interpreted above under *ruthveni*, which appears to intergrade with this form. The following U.S.N.M. and personal records of *sayi* are available, including that of the type (No. 1540) and a paratype (No. 1541) of the synonymous *mcclellanii* from Deaf Smith County. Reports are by counties.

BORDEN: Gail (Vernon Bailey). CARSON: 6 mi. W. Groom (May 28, 1934). CLAY: 1 mi. N. W. Jolly (Apr. 18, 1931). CROSBY: 2 mi. N. W. Crosbyton (Luther Hoyle, June 13, 1933). DEAF SMITH: Red River Valley (R. B. Marcy and Geo. B. McClellan, June 28, 1852). DONLEY: Jericho (May 28, 1934). ELLIS: 1 mi. N. W. Waxahachie (May 26, 1931). FOARD: 3 mi N.E. Thalia (Luther Hoyle, June 11, 1933). GRAY: 1 mi. W. Alanreed (May 28, 1934). MOORE: Dumas, and 1 mi. N. Etter (May 28, 1934). PECOS: 12 mi. N. E. Ft. Stockton (Luther Hoyle, June 16, 1933). POTTER: 8 mi. E. Amarillo (May 28, 1934). PRESIDIO: Paisano (Wm. Lloyd, July 21, 1890). REEVES: 1 mi. S. Red Bluff (Aug. 12, 1934). SHERMAN: 3 mi. S. W. Texhoma, and 2 mi. N. E. Stratford (May 28, 1934). VAL VERDE: Cave, 20 mi. N. Comstock (J. H. Gaut, May 9, 1903).

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SCIENTIFIC NOTES AND NEWS

Prepared by Science Service

NOTES

National Academy of Sciences.—Dr. WILLIAM WALLACE CAMPBELL retired from the presidency of the National Academy of Sciences on the expiration of his term of service and Dr. FRANK RATTRAY LILLIE, elected president at the Annual Meeting of the Academy, assumed his duties as President on July 1, 1935.

National Bureau of Standards.—The Edgar Marburg Lecture for 1935 was delivered by Dr. L. B. TUCKERMAN of the National Bureau of Standards before the American Society for Testing Materials in Detroit on June 26.

Doctor TUCKERMAN spoke on aircraft materials and testing, confining himself to the relations between the mechanical properties of the material and the design of parts. Future improvements in aircraft will come through better designs, rather than through stronger materials, because present designs can not utilize the full strength of materials already available.

Dr. W. F. MEGGERS, chief of the spectroscopy section, attended the meeting of the International Astronomical Union in Paris, July 10–17. Doctor MEGGERS is a member of the committee on wave lengths and most of his time was occupied in the work of this committee

Dr. H. C. DICKINSON attended the 30th anniversary summer meeting of the Society of Automotive Engineers, at White Sulphur Springs, West Virginia, June 16–21. While there he exhibited a new design of "Ride-Meter" or indicator for determining the riding qualities of automobiles. The ride-meter in its present form consists essentially of a pneumatic cushion, and record is made of the total amount of roughness experienced in any given trip. Doctor DICKINSON also exhibited a wobble-meter, jointly designed by himself and Mr. R. W. BROWN and Dr. F. A. MOSS, used to determine the fatigue reactions of passengers after riding in automotive vehicles.

To determine how winds stress large buildings, National Bureau of Standards scientists have built a model of the world's highest structure, New York City's Empire State Building, and several blocks of its surrounding buildings Subjected to regulated and artificial breezes in a 10-foot wind tunnel, this miniature Manhattan gives information that will allow engineers to design buildings that are safe in high windstorms with due regard to least possible cost.

Children's Bureau.—In response to numerous requests, the Children's Bureau made estimates as to the number of children removed from industry by the NRA codes. Employment-certificate statistics collected by the Children's Bureau indicate that in 1929 more children left school to go to work than in the previous year. By 1930, however, when the depression had begun, there was a drop of 46 per cent in the number of boys and girls going to work in manufacturing and mercantile industries Between 1930, when the last Census was taken, and 1933, when the codes went into effect, there was a further drop of at least 50 per cent On the basis of the 1930 census figures it is estimated that in that year between 120,000 and 150,000 children under 16 were gainfully employed in the occupations later affected by the 16-year age minimum of the codes. The textile industry alone employed approximately 20,000 children; the clothing industries nearly 9,000; and other branches of manufacturing something less than 40,000. Another 8,000 were

employed in hotels and restaurants, beauty parlors, and laundries; 28,000 were employed in mercantile establishments.

The higher age set by some codes for employment of minors in hazardous occupations affected some young people over the general code age of 16 Over three-fourths of the codes fixed 18 as a minimum age for employment in hazardous occupations. According to the 1930 census 12,000 minors between 16 and 18 were employed in saw and planing mills alone. The lumber and timber products code prohibited their employment under 18. Approximately 5,000 16-year-old laundry workers were removed from hazardous employment through the 17-year minimum of the laundry code It is roughly estimated that 50,000 16- and 17-year-old minors were prohibited from hazardous employment by the NRA code regulations.

Bureau of Fisheries.—In recognition of his scientific record in the Bureau, Western Maryland College conferred upon J. R. MANNING, chief technologist, the degree of Doctor of Science.

Dr. P. S. GALTSOFF left Washington in June to establish headquarters at the United States Fisheries Biological Laboratory, Woods Hole, Mass., for the conduct of oyster pest control investigations during the coming summer.

WILLIAM HAGAN, JR , was transferred recently from the Division of Fish Culture to the Division of Scientific Inquiry to take charge of field investigations on oyster pest control on the eastern shore of Virginia Mr. HAGAN will be in charge of the U. S S Kittery, which will serve as quarters for a considerable number of men detailed to drill control studies by the Transient Rehabilitation Camp at Fort Eustis, Va.

Dr. WILL M. F. THOMPSON, director of scientific investigations for the International Fisheries Commission, United States and Canada, who has been directing research on the Pacific halibut since the establishment of the Commission, visited the Bureau of Fisheries and conferred extensively with the Bureau's scientific staff at Cambridge, Mass., engaged in North Atlantic fisheries investigations, en route to the annual meeting of the International Fisheries Commission at Ottawa.

National Park Service.—Assistant Director H. C BRYANT left Washington headquarters late in June for a tour of inspection of a number of the national parks and monuments in the West

Dr. J VOLNEY LEWIS, geologist connected with the Service's Naturalist Division, has just completed a monograph on caves and caverns of the United States. Present plans call for the issuance of this work in mimeograph form.

Under the direction of EARL A. TRAGER, Chief of the Naturalist Division, Washington Office, a geological program for the national and state parks has been formulated. Plans call for the setting up of 8 districts, in each of which a geologic technician will supervise and coordinate all geologic projects.

Carnegie Institution of Washington.—Discovery of an orange-red pottery well, from which thirsty Maya Indians drew water centuries ago, is announced by OLIVER G. RICKETSON, JR. The ancient well, which shows how ingenious Mayas stored water, was unearthed at Quirigua, Guatemala, where one of the Mayan cities was located. The well consisted of a pipe of pottery which led down to a big pottery water jar. The jar was buried in stones and sand and served as a cistern. Holes in the jar below the water table permitted free entrance of water.

Conference of state and territorial health officers.—The regular meeting of state and territorial health officers beginning on June 18 considered as its principal business the formation of plans for the expenditure of $8,000,000 provided for in the Social Security bill as a fund for promoting and protecting the health of the nation.

Discovery of a new disease and progress already made toward its prevention were announced simultaneously by Dr. CHARLES ARMSTRONG, of the U. S. Public Health Service, and Lieut. Com. PAUL F. DICKENS, of the Navy Medical Corps. The malady, which has appeared in isolated instances in a number of states, has features resembling meningitis, infantile paralysis, and epidemic encephalitis, or sleeping sickness. The discoverers suggest the scientific name "acute lymphocytic choriomeningitis" for it. The agent causing the disease was found to be a filterable virus. Monkeys, mice and guinea pigs are susceptible to the virus causing the malady, and the two physicians suggest that "a reservoir of the disease may exist in animals." Tests show that a blood serum of patients who have recovered serves to protect experimental animals from the virus, but the serum has not yet been used in human patients to test its power to forestall development of the disease.

Solving problem of photosynthesis.—Announcement was made to a biological conference in Cold Spring Harbor, L. I., by Dr. DEAN BURK, U. S. Department of Agriculture, that he and HANS LINEWEAVER, working in the Bureau of Chemistry and Soils in Washington, have come five steps nearer understanding the baffling chemical processes by which the leaf manufactures carbohydrates. It is now only a matter of time, Dr. BURK said, until several more leaf reactions will be discovered. Dr. BURK compared the reaction of photosynthesis to an endless chain bucket pump in which the sun furnishes the power, the chlorophyll and another catalyst acting as buckets in pumping the carbon products to a higher energy level. The chemical equations he developed depend upon changes of energy content. The Department of Agriculture scientists experimented with a green alga, *Chlorella*, in the life of which little happens except the change of carbon dioxide to protoplasmic carbohydrates

Giant camera for survey.—The world's largest aerial camera, which can photograph a ground area of 760 square miles, or over twice that of New York City at a single "shot," has been built by Fairchild Aerial Surveys and Aerial Camera Companies for use by the Department of Agriculture in a mapping survey of central New Mexico.

Weighing 275 pounds without films, the camera has ten lenses mounted in two sets of five. When the ten lens shutters are snapped at exactly the same instant by a master electric trigger, ten negatives, making a composite print which measures 32×32 inches, are exposed. Soil Conservation Service workers, starting a survey from the air of the rugged and almost inaccessible terrain of central New Mexico about mid-July, will make first use of the new camera.

Proposed underground water resources survey.—A scientific attack on the drought problem is provided for in a plan for exploring, measuring and charting the underground water resources of the nation, especially in the drought-stricken areas, proposed by the U. S. Bureau of Mines. Application for $1,619,100 of Public Works funds was made by the Bureau for this purpose. Underground water supplies are now badly needed in many parts of the

United States, Bureau officials explain. A systematic survey of the nation's hidden water resources has been recommended by the National Resources Board. Electrical methods of geophysical exploration will be used for locating water and various geological formations in this survey, according to the plans.

Research by Department of Agriculture.—Scientific research that will benefit future generations, as well as the present, is contemplated by a bill introduced in the House by Rep. MARVIN JONES, of Texas. The measure has passed both House and Senate.

According to the terms of the bill, the Secretary of Agriculture "is authorized and directed to conduct research into laws and principles underlying basic problems of agriculture in its broadest aspects," and also to carry on investigations looking to improvements in handling and marketing, as well as "research relating to the conservation development of land and water resources for agricultural purposes."

The research thus contemplated is to supplement, not to replace, other researches now going under the aegis of the Department of Agriculture; but both activities are to be coordinated so far as practicable, and "shall be conducted by such agencies of the Department of Agriculture as the Secretary may designate or establish." The initial funds for this work will amount to $1,000,000 This sum will be increased by an additional $1,000,000 each year until the total reaches $5,000,000, and thereafter the special research fund will be maintained at the latter sum each year Forty per cent of the total in any year is to be expended under the direct supervision of the Secretary of Agriculture, in any places and for any research purposes he may approve within the scope of the act. The remaining sixty per cent will be prorated among state agricultural experiment stations according to the size of their respective rural populations. Funds thus allocated must be matched dollar for dollar by the states receiving them.

The establishment of new laboratories is within the authorizations of the act, since it is provided that funds may be used for the erection of buildings and the purchase or rental of land needed for the purpose. These laboratories might be set up in the major agricultural regions of the United States, in places designated by the Secretary of Agriculture.

Reporting Hurricanes.—The hurricane weather service of the U. S. Weather Bureau was placed on a decentralized basis on July 1. Instead of the single central office in Washington, three stations have been established in the South, at New Orleans, Jacksonville and San Juan, P.R , respectively. The Washington office will be directly concerned with only such tropical storm centers as move north of latitude 35 degrees, approximately the parallel of Cape Hatteras.

Ships at sea are asked by the Hydrographic Office, U. S. Navy, to radio reports of all hurricanes they may encounter. Radio dispatches may be sent in a special code, obtainable from the Hydrographic Office or from the Weather Bureau. Shore stations "talking" with ships in the neighborhood are authorized to forward to the U. S. Weather Bureau, Washington, by wire collect, information on storms thus received.

NEWS BRIEFS

Dr. HERBERT FRIEDMANN, Smithsonian Institution curator of birds, has made a survey of the forms of bird society reported from all over the world, and concluded that birds that are most advanced evolutionally are also the

most individualistic Birds that flock together most persistently belong to the more "primitive" zoological groups

BRADFORD WASHBURN, leader of the National Geographic Society's Yukon Expedition, has returned to Washington after four months in the field to make his report to Dr GILBERT GROSVENOR, president of the Society A two-thousand square mile blind spot, in southwestern Yukon Territory, a region of lofty mountain ranges and deep glacier-filled valleys and gorges, has been erased from the map of North America, he said

Dr A G GILLIAM, Dr W P DEARING and Dr J P LEAKE were sent to North Carolina from the U S Public Health Service to assist state and local health officials in fighting an outbreak of poliomyelitis, or infantile paralysis

PERSONAL ITEMS

Hon HENRY A WALLACE, Secretary of Agriculture, was granted the degree LL D , *honoris causa*, by Harvard University at the June commencement, and also received a similar degree from Columbia University

Dr HERBERT F PRYTHERCH, of the U S Bureau of Fisheries, has been elected president of the National Shellfisheries Association and chairman of the State Board of Directors of the North Carolina Fishermans Cooperative Association

Dr ISAIAH BOWMAN, chairman of the National Research Council and director of President Roosevelt's Science Advisory Board, addressed the American Association for the Advancement of Science on the value of a proposed program of intensive research on weather records of the past eighty years which he said should be valued "more than all the gold in the Klondike "

Dr WALTER A BLOEDORN, of George Washington Medical School, in addressing the meeting of the American Association for the Advancement of Science in Minneapolis, said that iron, one of the oldest medicines in the world, is still one of the most dependable for certain types of anemia

MRS KATHERINE K MADDEN, of Washington, with DR GEORGE E SHAMBOUGH, JR , of Chicago, announced at the Cincinnati meeting of the American Federation of Organizations for the Hard of Hearing a plan whereby deaf persons may make postmortem disposal of their ears for the purpose of scientific research

Fireflies that flash simultaneously in large numbers do not always behave alike They vary according to species, is the contention of GERRIT S MILLER, JR , of the U S National Museum, commenting in Science on an explanation offered by JOHN BONNER BUCK, of the Johns Hopkins University, for the simultaneous flashing of fireflies over a whole meadow or lawn Mr MILLER presented observations made by himself in Jamaica Here a different firefly species flashes in large groups or "constellations," but these "constellations," though within sight of each other, do not adopt the same flash-rhythm, as observed by Mr BUCK Instead, each group is a law unto itself for a time Then a disintegration of the rhythm sets in, and the flashes come wholly at random

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GEOPHYSICS.—*Testing a theory of the earth's interior.*[1] REGINALD A. DALY, Harvard University. (Communicated by L. H. Adams.)

The processes responsible for the structure of the visible part of the earth have been controlled by the physical properties of the invisible part. The character of this incomparably greater volume of material presents the most fundamental and important problem of physical geology. How shall it be solved?

Atomic physics and astrophysics are being guided to major discoveries by the testing of models of atoms and models of stars. Geodetic measurements and seismological results are becoming increasingly accurate by the use of theoretical models of the earth. Similarly, physical geology will be advanced by examining the merits of theoretical models of the globe, models constructed in the light of the myriad field and laboratory observations already published. As a result of such synthetic study the writer presented in his book *Igneous Rocks and the Depths of the Earth* of the year 1933 a preferred picture of terrestrial material. Since the manuscript of the book was sent to press new data from seismology, on the radioactivity of rocks, and on thermal gradients in the earth's crust, particularly the gradients given by R. H. Cleland for Pre-Cambrian rocks in Canada, suggest the need of changes of the earth model in detail, but seem to demand no change of principle.[2]

The present paper discusses the validity of this theoretical model with respect to the distribution of strength in the earth's body, as now constituted. The conditions of earlier epochs are not considered. "Strength" is defined as the power to resist the deforming tendency of a shearing stress indefinitely prolonged. The tests of validity form two groups. The first includes those that have been supposed, though apparently without warrant, to prove considerable strength in the deep interior of the planet. The second group give a positive result

[1] Substance of an address to the Geological Society of Washington, April 24, 1935. Received May 15, 1935.

[2] See CLELAND, R. H. Trans. Canad. Min. Inst. 33: 379. 1933.

and indicate extreme weakness in all of the earth-shells beneath a comparatively thin crust.

A MODEL OF THE EARTH

Essential characteristics of the earth-shells, according to the preferred picture of 1933, are summarized in the following table.

TABLE 1.—CHARACTERISTICS OF THE EARTH-SHELLS

Earth-shell	Average thickness (km)	Average density	Temperature (approximate)	Reaction to shear-stress	Strength
1. Crystalline crust. a. Continental segment	Circa 60	2 89	10°-1350°C.	Elastic	Considerable
b. Suboceanic (deep-Pacific) segment	Circa 75	3 03	1°-1400°	Elastic	Considerable
2. Vitreous, basaltic substratum	? (probably less than 400 km)	2 80–2 85 at top	1350°-1400° at top	Elastico-viscous	Vanishingly small
3. Vitreous silicate shell, more basic than 2	Ca 2300	Ca. 3 5–6.5	?	Elastico-viscous	Vanishingly small
Major discontinuity 4. Core, probably metallic iron	Ca 3500	Ca. 10.5–12 5	?	Elastico-viscous or fluid	Vanishingly small

Elastico-viscosity for the subcrustal shells is assumed: first, because the assumption seems to offer the only means of reconciling the high rigidity proved by the seismologist with the degree of isostasy proved by the geodesist; secondly, because the exalted temperature of those shells means thorough atomic agitation, and consequent instability of any space-lattice in the aggregations of atoms. The decay of rigidity may follow Maxwell's law, involving the first power of the stress-difference. However, when the stress-difference becomes extremely small, the law followed may be that of Adams and Williamson, involving the square of the stress-difference.[3] If the average time of relaxation were as much as 100 years, the stress-difference would become immeasurably small during a small fraction of a geological period. This whole idea, that most of the earth's body behaves under shearing stress like pitch, is of course not new to science.

[3] MAXWELL, J. C. Phil. Mag. 35: 134. 1868; ADAMS, L. H., and WILLIAMSON, E. D. Jour. Franklin Inst. 190: 619, 631. 1920.

OBJECTIONS TO ASSUMING AN ELASTICO-VISCOUS INTERIOR

1. The first argument against the validity of the model is based on clear proofs of high rigidity of the whole silicate shell of the earth, with respect to small stresses of short periods. Seismic and tidal waves give such stresses, and their propagation is so perfect that associated, non-elastic displacements, if real, are too small for measurement. On the other hand, Jeffreys has found that even the small stress-differences set up during the cycle of the variation of latitude appear to be accompanied by some plastic yielding of the earth's body. He has explained the apparent fact by supposing the subcrustal material to be elastico-viscous, with a time of relaxation of rigidity equal to about ten years.[4] Jeffreys' discussion is only one illustration of the manifest fact that rigidity has no necessary connection with strength.

The high rigidity, effective in all such cases of slight, periodic stressing, is regarded as a derivative of viscosity, enormously increased by the intense hydrostatic pressure exerted on subcrustal material. This explanation, though prompted by analogies found in Bridgman's experiments on the viscosity of organic liquids at high pressures, is frankly speculative and to be suspected until the results of more direct experimentation are in hand.[5] However, the combination of great rigidity and non-crystallinity in earth-shells below the depth of 80 kilometers or so is assumed partly for a quite different reason: that this hypothesis appears best to account for the major displacements of, and in, the earth's crust. Both lines of argument are manifestly subject to doubt, and the writer fully realizes the need of better geophysical support for this basal assumption regarding the connection between rigidity and the state of the earth's materials.

2. From deflection residuals and gravity anomalies Clarke, Helmert, Berroth, and Heiskanen deduced an elliptical form for the geoid in the plane of the equator. In other words, these authors were led to propose a triaxial ellipsoid as the approximate "figure of the earth." Heiskanen's calculations gave a difference of about 500 meters between the major and minor axes of the geoid at the equator. This would mean for the solid surface of the earth an equatorial ellipticity of about 1000 meters.[6]

[4] JEFFREYS, H *The Earth*, 2nd ed, Cambridge, Eng, p 266,1929.

[5] BRIDGMAN, P. W Proc. Amer. Acad Arts and Sciences, 61: 96 1926; *The Physics of High Pressure*, New York, chap. 12, 1931.

[6] HEISKANEN, W. *Gerlands Beitraege zur Geophysik*. 19: 356, 1928, with references to the earlier writers; cf. JEFFREYS, H. *The Earth*, 2nd ed., Cambridge, Eng., p. 222,1929.

Since geology knows no reason why the corresponding stresses could have been developed in recent geological time, the deduced triaxiality would mean practical strength at great depth. Yet there are several grounds for doubting the hypothesis of triaxiality. The number and distribution of gravity stations are still inadequate for solution of the problem. Its data are imperfect until our present ignorance of the correct basis for reducing the field observations of gravity is dispelled. The values of gravity found by Vening Meinesz in the extensive West Indian and East Indian regions do not agree with any triaxial formula.[7] After all, as Jeffreys points out, the hypothesis of triaxiality reduces deflection residuals and gravity anomalies only a few per cent. And, finally, the hypothesis ill accords with the ice-cap proof of minute or zero strength for the deeper earth-shells.

3. The Moon is elliptical in its equatorial section, the major and minor axes of the ellipse being found to differ by approximately 500 meters. The inequality, regarded as a frozen tide that was raised when the moon was much nearer the earth than it is at present, means notable stress-differences at relatively great depth below the surface. These stresses have been resisted for more than a billion years. Hence the lunar material at the depth concerned must have practical strength. Jeffreys has argued that the earth is homologous, of qualitatively similar properties.[8] However, there is good reason to believe: that the moon has cooled much faster than the earth, which is fifty times larger in volume and of mass eighty times larger; and hence that the moon early became crystallized to a far greater relative depth, if not to its actual center. Also in view of the low value of gravitation by the moon, it seems legitimate to explain the observed inequality of the lunar figure by the strength of crystallized rock; it is equally legitimate to question the argument for strength in the deeper earth-shells so far as this argument is based on an assumed homology between planet and satellite.

4. Many earthquakes have been shown to have originated around focal points from 100 to 700 kilometers below the earth's surface. As yet seismologists are unable to understand why seismic blows can be struck at such depths. The reality of the deep foci seems to add one more argument against the idea that the earth-shell involved is utterly weak. The question whether the shocks imply solid-elasticity or elastico-viscosity awaits an answer. In either case brittleness and

[7] See Heiskanen, W Gerlands Beitraege zur Geophysik, 36: 197. 1932; Vening Meinesz, F A *Gravity at Sea*, Netherlands Geodetic Commission Pub. 2: 109. 1934

[8] Jeffreys, H. *The Earth*, 2nd ed., p. 229, 1929.

sudden slips of the deep material are conceivable. Indeed the phenomena connected with the isostatic deformation of the earth's crust in response to unloading with deglaciation appear best explained by assuming spasmodic, vertical shears to depth of the order of 1000 kilometers. (See below.) However, these sudden displacements affect zones which in ground plan are thousands of kilometers long, and there is no obvious reason why the movements should cause specially energetic shocks at "points" in the zones. The same difficulty appears when the analogous mechanism of isostatic adjustment between erosionally unweighted continent and weighted sea-floor is studied. Probably the answer to the question will come when seismologists thoroughly understand why displacements along rifts at the surface and hundreds of kilometers long are accompanied by the actual, highly localized shocks. Pending further investigation it seems right to hold that the discovery of deep seismic foci does not disprove the rule of elastico-viscosity at depths exceeding 100 kilometers.

5. The existence of peneplains has been thought to demonstrate strength for the deeper earth-shells. According to the argument the earth's crust remains unmoved while heavy loads of wide spans are removed by secular erosion. During those millions of years isostasy is supposed to fail in each peneplained region, and stresses of some magnitude are supposed to reside in the material far below the surface. However, no proof of such significant departure from isostasy for any extensive peneplained area has yet been produced. In the United States as elsewhere many peneplained areas have kept nearly the same relation to their baselevels as they had during the removal of matter, and nevertheless exhibit no systematic gravity anomalies of negative character.

Further, the upwarping of peneplained surfaces does not necessarily mean previous failure of isostasy. The strongest warping is found in orogenic belts, where mountain-roots have been sunk deeply into the earth's body. Thus the isotherms were depressed. Their restoration to their original levels has taken millions of years. It seems fair to assume expansion of the material beneath the visible mountain-structure, and enough delay in the expansion to cause warping of a surface already peneplained. Then there is a second possibility, the slow heating and expansion of mountain roots by radio-activity. Whatever the cause, the upwarping of any peneplain can not be considered a priori evidence of important lack of isostatic balance in the region at any stage of its erosional history.

6. Because individual plus and minus areas of gravity anomaly appeared to have spans of 1000 or more kilometers, Barrell and Jeffreys attributed strength to the material at depths of hundreds of kilometers. For example, from the 1912 anomaly map of the United

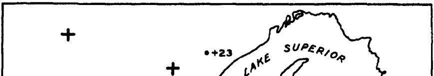


Fig 1.—Isostatic anomalies (in milligals) and (broken) lines of zero anomaly, separating plus and minus areas. Computations based on 18 stations and on the corrected Helmert 1901 formula for the figure of the earth; Pratt-Hayford depth of compensation assumed to be 113.7 kilometers (Special Publication No. 10, U. S. Coast and Geodetic Survey, Illustration No 2, 1912)

States (89 gravity stations) Barrell supposed one such area to have a width of 2800 kilometers, and a maximum departure from isostasy measured by the weight of 380 meters of rock. He therefore concluded that the earth-shells at depths exceeding 500 kilometers could permanently support decided stress-differences. From the data of the 1917 anomaly map, including measurements at 130 additional stations, Jeffreys came to a similar conclusion. However, as more and

more gravity stations in the United States are occupied, the areas characterized by anomalies of one sign tend to decrease to a notable extent. Some illustrations will make this important fact clear.[9]

a. On the 1912 map eight plus areas and four minus areas were

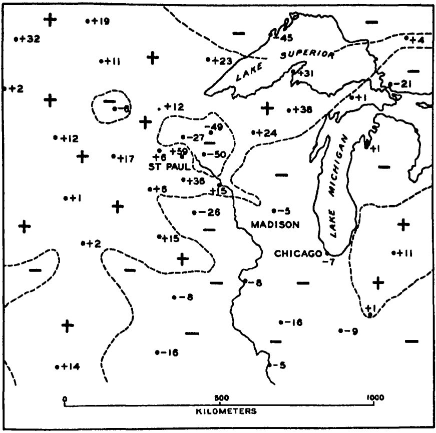


FIG. 2.—Isostatic anomalies (in milligals) and lines of zero anomaly in the same area as that shown in Fig 1. Computations based on 41 stations; otherwise as in the case represented by Fig 1 (Special Publication No. 40, U S Coast and Geodetic Survey, Illustration No. 11, 1917.)

contoured in the United States; on the 1917 map, thirteen plus areas and eight minus areas; on the map of 1924, seventeen plus areas and seven minus areas.

b. The wide plus area shown on the 1912 map west and southwest

[9] See BARRELL, J. Jour Geology, 23: 30 ff 1915; JEFFREYS, H *The Earth*, 2nd ed., p. 201, 1929; HAYFORD, J F, and BOWIE, W U S Coast and Geod. Survey, Spec Pub. 10, Illustration no. 2 (anomaly map) 1912; BOWIE, W ibid, Spec. Pub. 40, fig 13 (anomaly map), 1917, and ibid, Spec Pub. 99, fig. 7 (anomaly map), 1924; *Principal Facts for Gravity Stations in the United States*, with map, issued by the U. S. Coast and Geodetic Survey, 1934.

of the Great Lakes (Fig. 1) was greatly narrowed on the 1917 map (Fig. 2), after only a relatively small addition to the field data.

c. The region covered by Figure 3 was, on the 1917 map, marked as characterized by positive anomalies, except for the small part at the northwest corner, indicated by the stipple pattern. The field measurements available in 1934 show the necessity of breaking up this wide plus region into at least three plus and three minus areas, as depicted by the drawing. In the same region the mean anomaly with

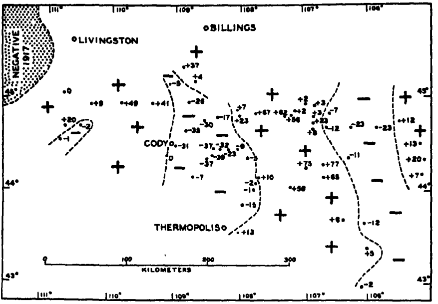


Fig. 3.—Isostatic anomalies (in milligals) and lines of zero anomaly in Wyoming. Computations based on the 1930 International formula; Pratt-Hayford depth of compensation assumed to be 113.7 kilometers (Data circularized by the U. S. Coast and Geodetic Survey, 1934.)

regard to sign was, according to the facts known in 1917, +28 milligals; according to the fuller data of 1934, it is +14 milligals. Evidently the region is more nearly in perfect isostatic adjustment than had been thought.

d. In 1934 twelve stations in northwestern Texas (Nos. 408–419 inclusive) were reported. Eight show plus anomalies and four minus anomalies, with a mean anomaly with regard to sign of +7 milligals. On the 1917 map the whole of the same region was marked with negative anomaly.

e. Central Kansas, between the meridians of 96°30′ and 100° W. Long., was mapped in 1917 as belonging entirely to an area of positive

anomaly, but the values of gravity reported in 1934 give in the same region two negative belts and an intervening positive belt.

f. On the 1917 map the State of Connecticut appears as a region of negative anomaly; the great majority of the new stations, reported in 1934, give positive anomalies, with mean of +22 milligals.

g. Similarly, qualitative and quantitative changes have been compelled in the Chesapeake Bay region because of the addition of the 1934 data to those of 1917.

However, there is one important exception to the rule of diminution of anomalies in the United States with the increase of stations. The Pacific coast belt of continuously negative anomalies, shown on the 1917 map, is not essentially narrowed by the addition of the data from stations occupied later. This belt is not far from 1000 kilometers wide and extends beyond the actual coast to some line to be drawn east of Vening Meinesz's stations at sea. The maximum anomaly on land south of the Columbia River (data of 1934) is −83 milligals and the mean with regard to sign is −20 milligals. The mean anomaly for the stations at sea, just off the California coast, is +20 milligals.

Explanation of these apparent departures from isostatic equilibrium is not obvious. Bowie regards the departures as not real and attributes the negative anomalies to the low density of the more superficial rock formations along the coast. Heiskanen has offered a quite different solution to the problem in terms of the Airy theory of isostasy.[10] Neither of these experts finds compelling evidence that there is actual failure of isostasy in the coastal belt. Some failure there may be, merely because this part of the earth has not yet had time to reach equilibrium after its late-Tertiary, Cordilleran disturbance.

The problem raised by the wide coastal belt is baffling, but the writer still believes that the study of gravity values in the United States does not prove the existence of rock loads too great to be borne by the strength of the crust alone.

In review, it appears that each of the six objections to the idea of almost or quite perfect weakness for all earth-shells below a level not more than 100 kilometers down from the surface lacks cogency. Attention will now be drawn to the affirmative tests, three in number. All will be presented merely in outline.

[10] BOWIE, W. *Investigations of Gravity and Isostasy*. U S Coast and Geod Survey, Spec. Pub. 40: 76 1917; HEISKANEN, W. Annales Acad. Scient. Fennicae 36 (3): 128. 1932

AFFIRMATIVE TESTS

1. A somewhat detailed discussion of the first appears in the writer's book *The Changing World of the Ice Age.*[11] There it was shown that each principal Pleistocene ice-cap caused both elastic and plastic deformation of the globe, the result being delayed but ultimately close isostatic adjustment for the load of ice. After the melting of each great cap, with corresponding removal of superficial load, isostatic adjustment in the reverse sense has progressed so far that the residual stress-differences in the earth are all extremely small. Nevertheless the adjustment still continues, indicating vanishingly small strength for the material that has been, and is, flowing. Further, there is evidence that, while the horizontally directed flow may be distributed through all depths, it has been concentrated largely below the 1000-kilometer level. If so, the weakness of the deep interior must be nearly or quite absolute.

2. The second test is based on an assumption: that the earth's internal weakness is due to temperature so high as to prevent crystallization at all depths greater than about 75 kilometers below the surface. According to the facts of geology and petrology the uppermost layer of the non-crystalline or vitreous material is best regarded as of basaltic composition, and is conveniently called the basaltic substratum. The layer immediately above—the lower part of the earth's crust—has the elastic properties reasonably assigned to basalt, when crystallized under pressure greater than 10,000 atmospheres. There the velocities of earthquake waves probably exceeds the velocities in the vitreous material just beneath. If so, the time-distance curve of the seismic waves should exhibit the discontinuity that goes with a "shadow zone," analogous to that well established and explained by the sudden drop in velocities at the transition from the earth's silicate shell to her "iron" core. In fact at epicentral distances between about 1000 kilometers and 1700 kilometers there is no strong seismographic record of longitudinal or transverse waves that have penetrated the substratum. For stations at these distances from epicentra the seismograms give no record at all for the waves described, or else record very weak impulses from them. The existence of these slight impulses may be attributed to diffraction along the discontinuity. The theory of the shadow zone here considered will soon be discussed in printed form by the writer's colleague, Dr. L. D. Leet. The reality of the zone has already been suggested by B. Gutenberg.[12] Seismologists will do well to examine still more carefully

[11] Yale University Press, Chapter 4, 1934.

the evidence for the shadow zone and the corresponding change of state at moderate depth in the earth.

3. The remaining test is this: How does the suggested model of the earth *work* with respect to the major problems of petrogenesis, orogeny, and crust-warping? In the writer's opinion this model offers more and better solutions to these problems than any other yet imagined, and is therefore worthy of further testing in the field and laboratory.

CHEMISTRY.—*The development of thermochemistry.*[1] FREDERICK D. ROSSINI, National Bureau of Standards.

Thermochemistry may be defined as that branch of chemistry which treats of the changes in *intrinsic energy* or *heat content* associated with chemical reactions.

The first quantitative measurement of the heat evolved in a chemical reaction was made some years before 1800, and, in the early years of the science, contributions to thermochemistry were made in France, Great Britain, and Russia, by chemists who were famous for other accomplishments as well: Lavoisier, Dalton, Davy, Despretz, Hess, Dulong, Graham, and Andrews.

While these first measurements in thermochemistry were very crude as judged by our present day standards, nevertheless great credit is due these pioneers for their work and for their insight into the meaning of their experimental results. Even at that early day, these investigators sensed the idea that the heat energy associated with a given reaction was in some way related to the chemical activity of the substances concerned. Before 1850, there were extant in the literature data of varying degrees of accuracy on the heats of a large variety of chemical reactions: heats of solution of salts and of their hydrates in water; heats of neutralization of acids and bases in aqueous solution; heats of combustion of gases and of metals in oxygen; heats of direct combination of metals with non-metals.

Soon after 1850, several things occurred which were destined to raise thermochemistry to a very high place. The first of these happenings was the general acceptance of the first law of thermodynamics, and the other was the arrival into the field of thermo-

[11] GUTENBERG, B. Gerlands Beitraege zur Geophysik, 17. 364. 1927; MÜLLER-POUILLET, *Handbuch der Physik*, 5: 670. 1928; Bull Seism Soc America. 21: 216. 1931.

[1] An address delivered before the Chemical Society of Washington, March 14, 1935, on the occasion of the award of the Hillebrand Prize for 1934. Publication approved by the Director of the National Bureau of Standards of the U S. Department of Commerce. Received May 3, 1935.

chemistry of Julius Thomsen, a Danish chemist at Copenhagen, and of Marcellin Berthelot, a French chemist at Paris.

These two investigators independently announced the same principle relating heat of reaction with chemical affinity, stating that the heat of a given reaction was a direct measure of the chemical affinity of the substances concerned, and that only those reactions would proceed which were accompanied by an evolution of heat energy. Spurred on by their profound belief in the validity of this direct relation between heat content and chemical affinity, Thomsen and Berthelot amassed an enormous amount of data on heats of reaction. Each made notable contributions to the technic of calorimetry. Thomsen developed a reaction vessel for measuring the heats of combustion of gases at constant pressure; Berthelot developed a reaction vessel for measuring the heats of combustion of organic liquids and solids in a closed bomb. Other chemists of the day became imbued with the enthusiasm of Thomsen and Berthelot for the importance of data on heats of reaction, and thermochemistry assumed a lofty place in the science reaching its peak at about the time of the publication of Thomsen's monumental four volumes of thermochemical data in 1882–1886.

By this time, however, the second law of thermodynamics had come into chemistry, and its true relation to chemical reactions was being developed by Clausius, Gibbs, Helmholtz, Van't Hoff, and others. It was shown that the true measure of the chemical affinity of a substance was not its heat content, but a quantity (which we now call free energy) differing from the heat content by a term involving the product of the entropy and the absolute temperature.

Before the close of the century, both Thomsen and Berthelot accepted the second law of thermodynamics, and acknowledged that the heat of reaction alone was only an approximate measure of the chemical affinity, and that in some cases their old principle yielded completely erroneous results. A decline in the work of thermochemistry then set in, and investigators turned their attention to those measurements which would yield true values of chemical affinity or free energy. In the three decades following 1900, researches in thermochemistry were, with a few notable exceptions, sporadic and casual, and our main body of thermochemical data remained those of Thomsen and Berthelot.

About 1906, Nernst pronounced this famous heat theorem, which, with certain limitations, became accepted as the third law of thermodynamics. The third law made possible the determination of en-

tropies by measurement of heat capacities down to low temperatures, near the absolute zero, and combination of these values of entropy with data on heats of reaction yielded values of the changes in free energy. The full power of the third law, particularly with regard to organic substances, was soon appreciated, and a great number of these entropy data were obtained. But it was soon found that the existing data on heats of reaction were not comparable in accuracy with the data on entropies, and that the uncertainties in the resulting values of free energy were practically equal to the uncertainties in the data on heat content. This was no reflection upon the work of Thomsen, Berthelot, and their coworkers, whose values more than satisfied the requirements of the 1880's, but it indicated a real need for new and accurate data on heats of reaction.

About 10 years ago, a new and powerful tool for chemical thermodynamics was developed. This was the use of spectroscopic data on the energy levels of gaseous molecules for calculating very accurate values of entropy. These values of entropy were combined with data on heats of reaction to obtain values of the changes in free energy. But, in order to obtain the full benefit of the accurate spectroscopic values of entropy, it was necessary that data on heats of reaction be of the highest possible accuracy. Thus arose another real need for new and accurate thermochemical data.

Again about 10 years ago, the theoretical physicists and chemists began applying the new mechanics to the calculation of the energies of the atomic linkages in molecules. In order to correlate and check the calculations of their theories, accurate data on heats of formation were required. And so arose a third real need for new and accurate values of heats of formation.

Thus, about a decade ago, the stage was set for a renaissance in thermochemistry. One of the first to sense this need and to promote a renewed interest in thermochemical measurements was the late E. W. Washburn, who, as editor-in-chief of the International Critical Tables, was in a particularly good position to appreciate the inadequacy of the existing data.

Though many new thermochemical values have been obtained in the past few years, chiefly in the United States and Germany, we still depend upon many of the data obtained half a century ago. It should be pointed out that Thomsen, Berthelot, and their coworkers had not the advantages of our modern calorimetric apparatus and technic, nor of our pure substances, and therefore the value of their work should not be judged on the basis of present day accuracy. Fifty

years ago, an accuracy of 1 part in 1000 was as remarkable in calorimetry as is 1 part in 10,000 today. It can be said, in general, that the accuracy requirements of thermochemical data have increased about tenfold in the past half century.

Today, the problem of obtaining a reliable value for the heat of a given reaction resolves itself into two parts: First, one must investigate the purity of the given reaction as it proceeds under the conditions of the calorimetric experiment, and determine to what extent, if any, side reactions occur. In the time of Thomsen and Berthelot, because of the less rigid requirements of accuracy, the purity of the calorimetric reaction was not investigated as fully as it is today. Second, one must measure the heat of the reaction in terms of a fundamental unit of energy. As recently as twenty years ago, the accepted calorimetric unit of energy, called the calorie, was defined in terms of the heat capacity of water. From the standpoint of chemical thermodynamics, this caloric was not a satisfactory unit of energy, but it was then the only practical one available. Today, we make our measurements in terms of a fundamental unit of electrical energy, the joule. We do also report our thermochemical values in calories, but these calories are obtained from the fundamental joule by means of an arbitrarily defined factor, and the resulting defined calorie bears no relation, except incidentally and historically, to the heat capacity of water.

The principle of the modern calorimetric method for measuring heats of reaction is to compare the heat evolved by a measured amount of chemical reaction with the heat evolved by a measured amount of electrical energy, using the calorimeter as the comparator for the two kinds of energy. In this substitution method, the calorimetric conditions are made practically identical in the two kinds of experiment, so that many of the common calorimetric errors are eliminated.

The ultimate end of experimental thermochemistry is the assembly of a table of values from which one may calculate accurately the heat of every one of the infinite number of theoretically possible chemical reactions. Fortunately, it is not necessary to measure the heat of every possible chemical reaction in order to compile such a table, but only to determine the heat of formation, from its elements, of every chemical substance. The determination of the heat of formation of a substance from its elements requires only the measurement of the heat of a reaction in which all the reactants and products, except the given substance, are substances whose heats of formation,

from their elements, are known. Actually, in order to know the heats of formation of 10,000 chemical compounds, including hydrocarbons, it is necessary to measure the heats of less than 10,000 different reactions, because of a simplifying rule for some of the higher hydrocarbons. With these 10,000 values, one can calculate the heats of many, many times that number of chemical reactions.

Fortunately for the peace of mind and the economic security of investigators in thermochemistry, the possibility of the complete compilation of the ultimate table of heats of formation is extremely remote, because, with the passing of time, some values are continually becoming obsolete with respect to accuracy, and furthermore, many new compounds whose heats of formation must be determined are continually being synthesized or discovered by the organic and inorganic chemists.

PALEONTOLOGY.—*Descriptions of Paleozoic fossils from the Central Basin of Tennessee.*[1] R. S. BASSLER, U. S. National Museum.

In a volume entitled "The Stratigraphy of the Central Basin of Tennessee," published in 1932 as Bulletin 38 of the Division of Geology of the State of Tennessee, the writer included plates illustrating the characteristic fossils of the various Paleozoic formations discussed. Among these guide fossils were forty-one new species of invertebrates and algae for which there was no place for their description in the text, although in the explanation of the plates the exact horizon and locality were given in addition in some instances to comparisons with well known forms. This stratigraphic volume was in press for several years, during which time the rules of nomenclature were changed so as to disallow the recognition of species figured but unaccompanied by descriptions. This article is issued to remedy this deficiency in the present case. For economy, the citations to the Tennessee volume are restricted to noting the plate and figure in parenthesis after each of the species. The types of all the following species are the property of the U. S. National Museum.

Solenopora compacta cerebrum Bassler, 1932 (pl. 12, figs. 1, 2)

This common widespread Ordovician alga is represented in the Hermitage formation by large, much convoluted masses resembling a brain, for which reason the varietal name *cerebrum* was proposed. Careful study of this

[1] Published by permission of the Secretary of the Smithsonian Institution. Received May 29, 1935.

genus will probably show the present variety to be worthy of specific standing.
Trenton (top of Hermitage): 6 miles northwest of Carthage, Tenn.

Buthotrephis inosculata Bassler, 1932 (pl. 9, fig. 3)

A fucoid alga consisting of rounded, slightly flattened stems 6 to 8 mm. in diameter, branching dichotomously in the same plain at intervals averaging 30 mm , and also penetrating limestone layers several feet thick until they are completely occupied with these remains.
Black River (Tyrone formation): Hoover's Mills, west of Woodbury, Tenn.

Licrophycus libana Bassler, 1932 (pl. 5, fig. 9)

This fucoid occurs so often on limestone surfaces in spreading, fanshaped fronds arising from a simple stem which by repeated division expands to a diameter of 50 mm. and often overlying each other so that it must represent the remains of a definite organism instead of inorganic markings as regarded by some authors. Although closely related to the type of the genus, *L. ottawense* Billings, the present species is distinguished by its smaller, narrower, shorter, more frequently dividing stems.
Stones River (Lebanon limestone): 2 miles south of Murfreesboro, Tenn

Camarocladia gracilis Bassler, 1932 (pl. 8, fig. 4)

This primitive spongelike organism of uncertain classification is distinguished from the genotype, *C dichotoma* Ulrich and Winchell, by its stouter, less regularly dividing branches. *C. rugosa* Ulrich, a related species, is still unfigured and all the fossils of this nature require more study.
Black River (Tyrone limestone): Near Dixon Springs, Tenn.

Camarocladia implicatum Bassler, 1932 (pl. 5, fig. 10)

Similar to the preceding in general characters but differing in that the branches are 5 mm wide, divide at intervals of 15 or more mm., and form a closely matted mass.
Stones River (Lebanon limestone): Lebanon, Tenn.

Saccospongia massalis Bassler, 1932 (pl. 15, figs. 3, 4)

Sponge forming masses of 100 or more mm. in height and width, composed of frequently dividing, closely united branches about 15 mm. in diameter, each with a central canal 7 or 8 mm. wide and with the usual porous structure of *Saccospongia* visible at the surface, three of the pores occurring in 10 mm.
Trenton (Cannon limestone): 2 miles east of Hartsville, Tenn.

Saccospongia laxata Bassler, 1932 (pl. 15, figs. 1, 2)

A branching sponge similar to *S. danvillensis* Ulrich in growth, but differing in the much larger pores of its network, 4 occurring in 10 mm. longitudinally in contrast to 7 of the mentioned related species.
Trenton (Cannon limestone): Near Carthage, Tenn.

Cryptophragmus arbusculus Bassler, 1932 (pl. 16, fig. 9)

Hydrozoon with the transverse partitions and other internal structure

of *C. antiquatus* Raymond, the genotype, but with a stout, frequently branched colony, the branches averaging 10 mm. in diameter.

Trenton (Cannon limestone): 4½ miles east of Hartsville, Tenn

Tetradium? carterensis Bassler, 1932 (pl. 7, figs. 2, 3)

Coral of solid cylindrical stems, 30 to 40 mm. in diameter, composed of somewhat flattened corallites about 2 mm. in their longer diameter, showing a tendency to imbricate. No septa observed; generic position doubtful.

Black River (Carters limestone): 2 miles southeast of Priest, Tenn.

Tetradium saffordi Bassler, 1932 (pl. 19, fig. 2)

Colony a reticulate mass made by cells having the characteristic 4 septa and arranged in chainlike unilinear or bilinear rows uniting so as to form broad meshes 20 mm. in diameter.

Trenton (Cannon limestone): 2 miles east of Milton, Tenn.

Tetradium laxum Bassler, 1932 (pl. 18, figs. 10–12)

Corallite with septal structure of *Tetradium*, forming masses 70 or more mm. in diameter consisting of loosely growing single tubes each about 1 mm. in diameter, sometimes isolated but often adhering in unilinear sheets, all forming an open network with meshes averaging 7 mm in width.

Trenton (Cannon limestone): 2 miles east of Hartsville, Tenn.

Tetradium ulrichi Bassler, 1932 (pl 19, fig. 1)

Like *T saffordi* Bassler in general growth and structure, but meshes are only about half as broad.

Trenton (Cannon limestone): 2½ miles northwest of Woodbury, Tenn.

Columnaria [alveolata] minor Bassler, 1932 (pl. 11, figs. 1, 2)

Corallum small, composed of polygonal thin-walled corallites in close contact, 2½ mm. wide when mature, each with a primary set of 12 septa extending well towards the center and a shorter secondary set The small corallites distinguish this species which was figured as a variety, since 5 mm. is the average width in *C. alveolata.*

Trenton (Basal Hermitage): 1 mile south of Belfast, Tenn.

Nyctopora [Columnaria] crenulata Bassler, 1932 (pl. 13, figs. 3, 4)

Corallum of small, rounded masses composed of polygonal thin-walled corallites in close contact, with 5 to 6 in 6 mm., each corallite with 8 primary septa extending a short distance into the tubes and a set of shorter secondary septa. Tabulae in two zones, a crowded one where two occur in a tube diameter, and the other where they are spaced on an average of a tube diameter apart. No mural pores.

Trenton (top of Hermitage): 4 miles south of Carthage, Tenn.

Lichenaria globularis Bassler, 1932 (pl. 13, figs. 1, 2)

Small globular masses, composed of polygonal, thin-walled corallites with 8 to 9 in 6 mm , without septa or mural pores Tabulae developed at intervals of twice the tube diameter in the uncrowded zone, but in the other zone 2 or 3 occur in the same space.

Trenton (top of Hermitage): 6 miles northwest of Carthage, Tenn.

Lichenaria grandis Bassler, 1932 (pl. 12, figs. 7, 8)

Similar to *L. globularis* but more massive and with larger corallites, of which there are 6 in 6 mm. Septa absent; tabulae present and spaced as in the previous species.

Trenton (top of Hermitage): Near Bradyville, Tenn.

Enopleura punctata Bassler, 1932 (pl. 18, fig. 9)

This well marked cystid is distinguished from the genotype, *E. balanoides* (Meek) by its flattened theca and especially by its highly punctate surface.

Trenton (Cannon limestone): ½ mile north-northeast of Pulaski, Tenn.

Scolithus columbina Bassler, 1932 (pl. 16, fig. 8)

Type specimen a piece of fine-grained dove limestone pierced by worm borings, tubes about 0.5 mm. in diameter filled by crystalline calcite and spaced at intervals of several mm. The minuteness of the borings distinguish this from all other species.

Trenton (base of Cannon limestone): Near Franklin, Tenn

Amplexopora convoluta Bassler, 1932 (pl. 12, figs. 3, 4)

Bryozoan zoarium, a convoluted mass of 40 or more mm. in diameter, made up of closely intertwining branches composed of angular zooecia with the wall and acanthopore structure of *Amplexopora* and with 8 occurring in 2 mm In vertical sections the immature region has diaphragms at intervals of 3 to 4 tube diameters, but in the mature zone 3 occur in one tube diameter.

Trenton (top of Hermitage): 2 miles west of Hartsville, Tenn.

Stellipora stipata Bassler, 1932 (pl. 11, figs. 3, 4)

Zoarium of incrusting lamellae with closely spaced star clusters in which the rays are narrow and leave little space between them for mesospores. In the genotype, *S. antheloidea* Hall, the clusters are much farther apart and each exhibits at its center a broad area of mesopores

Trenton (top of Hermitage): 2 miles east of Cottage Home, Tenn.

Lioclemella bifurcata Bassler, 1932 (pl. 25, fig. 21)

Similar to the genotype, *L. ohioensis* Foerste, in zooecial structure and pointed base for articulation, but differing in that the zoarium bifurcates forming a distinct prong-shaped object; the zooecia are smaller (8 in 2 mm.) and the mesopores smaller and more numerous.

Richmond (Fernvale formation): 2½ miles northwest of Pulaski, Tenn.

Sowerbyella lebanonensis Bassler, 1932 (pl. 5, figs 7, 8)

Brachiopod shell similar to *S clarksvillensis* and related species, but distinguished by the surface markings of very fine striae with 3 or 4 delicate ribs alternating with a single larger one, with cardinal extremities somewhat angular and the dorsal lamellae extending almost to the front of the valve. Surface flat to gentle convex.

Stones River (Lebanon limestone): Shelbyville, Tenn.

Rafinesquina hermitagensis Bassler, 1932 (pl. 12, figs. 5, 6)

Shell of *R. fracta* group but rather strongly convex in the median region

and without any geniculation. Differs also in the greater breadth of the valves in contrast with the length, an average shell being 22 mm. long by 30 mm. wide.

Trenton (near base of Hermitage): 2 miles south of Middleton, Tenn.

Strophomena odessae Bassler, 1932 (pl. 25, figs. 7–12)

Shell similar to *S. parvula* Foerste, but differing in its general proportions, smaller size, less angular cardinal extremities and finer surface markings.

Richmond (Fernvale formation): 2½ miles northwest of Pulaski, Tenn.

Tentaculites obliquus Bassler, 1932 (pl. 11, fig. 9)

Shell 8–10 mm. long, 1 mm. in greatest diameter, differing from other species of the genus in its slightly curved form.

Trenton (Hermitage formation): Danville, Ky.

Hormotoma columbina Bassler, 1932 (pl. 18, figs 1, 2)

Shell similar to *H. major* Hall, differing in a smaller apical angle making it narrower and less robust. *S trentonensis* Ulrich and Scofield is also similar but is a shorter and more rapidly enlarging shell

Trenton (Cannon limestone): 1 mile southwest of Franklin, Tenn.

Lophospira ulrichi Bassler, 1932 (pl. 17, figs 5, 6)

Related to *L sumnerensis* Safford, but characterized by its low spire and unusual breadth. An average shell measures 22×22 mm.

Trenton (Cannon limestone): Near Hartsville, Tenn

Ctenodonta hermitagensis Bassler, 1932 (pl 11, figs. 7, 8)

Similar to *Ctenodonta pectunculoides* in general outline and dentition, but shell smaller and beak more produced with general surface marked by strong concentric lines

Trenton (top of Hermitage): 3 miles east of Mt Pleasant, Tenn

Leperditia pondi Ulrich and Bassler 1932 (pl. 21, fig. 8)

A *Leperditia* with valves 16×12 mm., in length and height, characterized by the unusually equal curvature of both anterior and posterior ends. Surface smooth with a narrow rim and slightly developed ocular tubercle in the anterior dorsal third

Trenton (Catheys formation): Nashville, Tenn

Isochilina apicalis Ulrich and Bassler, 1932 (pl. 21, fig. 9)

An *Isochilina* with valves about 11 by 6½ mm. with eye tubercle close to the dorsal margin and a ridge almost one third the length of the valves just below the center and parallel to the hinge line.

Trenton (Catheys formation): Nashville, Tenn

Isochilina columbina Bassler, 1932 (pl. 17, fig. 2)

A narrow, elongate *Isochilina* with dimensions of about 9×5 mm. with smooth surface, no marginal rim and a minute eye spot close to the anterior dorsal angles.

Trenton (Cannon limestone): Nashville, Tenn.

Isochilina nelsoni Ulrich and Bassler, 1932 (pl. 21, fig. 10)

Carapace equivalved, each valve about 13×7 mm., with surface smooth and a narrow rim along the free margins and with well developed ocular protuberance and accompanying nodes in the dorsal section.
Trenton (Catheys formation): Nashville, Tenn.

Aechmina longicornis Ulrich and Bassler, 1932 (pl. 27, fig. 6)

An *Aechmina* distinguished by the spine arising from the anterior half of the dorsal edge of the valves, which has a broad base and narrows to a point abruptly. A row of minute spicules occurs along the free margin of the valve. Valves excluding spine 0.9×0.5 mm.; spine 0.7 mm. long.
Kinderhook (Ridgetop shale): Mt. Pleasant, Tenn.

Ulrichia tenuimuralis Ulrich and Bassler, 1932 (pl. 27, fig. 14)

This species is particularly marked by the presence of a ridge close to the free margin and by a large oval node occupying the central part of the dorsal half of the valve. A smaller node anterior to this and the reticulate surface complete its characters. Valves 1 by 0.6 mm.
Kinderhook (Ridgetop shale): Mt. Pleasant, Tenn.

Paracythere cornuta Ulrich and Bassler, 1932 (pl 27, fig 13)

A Cythere-like ostracod with a small but prominent node near the dorsal in the narrow anterior part, with a much broader posterior end, and with surface marked by concentric lines arranged around a small muscle spot posterior to the node. Valves 1 by 0 6. mm.
Kinderhook (Ridgetop shale): Mt. Pleasant, Tenn.

Monoceratina [Bursulella] tennesseensis Ulrich and Bassler, 1932 (pl 27, figs. 11, 12)

A subtriangular-shaped ostracod with the apex of the triangle below and formed by the continuation of the ventral edge into a strong prominent spine. Valve excluding spine 1.5 by 1.1 mm.
Kinderhook (Ridgetop shale): Mt. Pleasant, Tenn.

Beyrichiopsis modesta Ulrich and Bassler, 1932 (pl. 27, fig. 10)

This species differs from the genotype, *B. fimbriata* Jones and Kirkby, in that the surface markings are reduced to a single, small rounded post-median node, and that the frill extending from the edges of the valve is of more uniform diameter throughout. Valve with frill 1 by 0.6 mm.
Kinderhook (Ridgetop shale): Mt. Pleasant, Tenn.

Beyrichiopsis pulchra Ulrich and Bassler, 1932 (pl. 27, fig. 1)

Distinguished from the associated *B. modesta* by its larger proportions, the very spinous surface, the small rounded subventral node and especially the double row of spines representing the frill paralleling the free edges. Valve measuring 1.8 mm. by 1 mm.
Kinderhook (Ridgetop shale): Mt. Pleasant, Tenn.

Allostraca fimbriata Ulrich and Bassler, 1932 (pl 27, fig. 5)

This, the only known species of the genus, is distinguished by its Cythere-like valves with a very broad subcentral eye or muscle spot, a distinctly

granular surface, and a prominent striated frill extending some distance beyond the free edges of the valves. Valve including frill 1.6 mm. by 0.8 mm.

Kinderhook (Ridgetop shale): Mt. Pleasant, Tenn.

Paracythere granopunctata Ulrich and Bassler, 1932 (pl. 27, fig. 4)

Outline and surface markings of valve much as in *Allostraca fimbriata* except that the striated marginal rim of the latter is lacking. Valve 1.7 mm. by 1 mm.

Kinderhook (Ridgetop shale): Mt. Pleasant, Tenn.

Barychilina lineata Ulrich and Bassler, 1932 (pl. 27, figs. 2, 3)

Distinguished from other species of the genus by the delicate concentric lineate structure of the surface markings. Valves 1 6 mm. by 0.9 mm.

Kinderhook (Ridgetop shale): Mt Pleasant, Tenn.

HYDROLOGY.—*Indian Hot Springs, Graham County, Arizona.*[1]

M. M. KNECHTEL, U. S. Geological Survey. (Communicated by O. E. MEINZER.)

The health resort known as Indian Hot Springs, at Eden, Arizona, is in sec. 17, T. 5 S., R. 24 E., about 8 miles northwest of the town of Pima, Arizona. (See fig. 1.) Here 5 thermal springs and a flowing well,

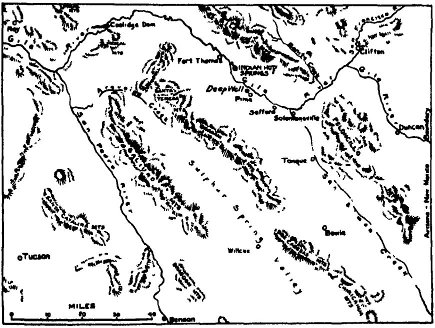


Fig. 1.—*Map of part of southeastern Arizona, showing location of Indian Hot Springs.*

[1] Published with permission of the Director of the United States Geological Survey. Received June 10, 1935.

having a combined discharge of about 320 gallons a minute, furnish water for general use at the adjacent hotel, for several Roman baths, and for a large swimming pool. Most of the water, however, escapes unused and runs in ditches directly to the Gila River. The elevation of the springs is about 2,820 feet above sea level.

The writer's study of Indian Hot Springs was made late in 1933 in connection with an investigation by the United States Geological Survey.

The springs occur in a small reentrant in the face of a terrace that was carved during Pleistocene time out of lacustrine sedimentary

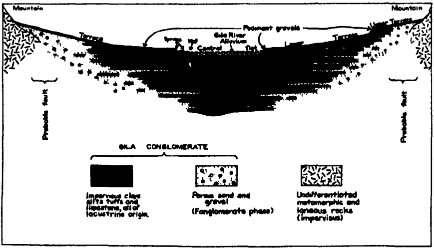


Fig. 2—Interpretative cross-section of the Gila valley looking southeastward near Indian Hot Springs.

deposits that form part of the Gila conglomerate (in this area Pliocene, at least in part). These deposits are poorly exposed in the locality of the springs, and their local structure is therefore unknown. In this valley, however, the lake beds and fanglomerates of the Gila conglomerate are in general not much disturbed. (See fig. 2.)

The well which is known as the "Beauty Spring," is about 600 feet deep and discharges 156 gallons of water a minute with a temperature of 119°F. Spring No. 1 yields 145 gallons of water a minute at 116°F.; spring No. 2 yields 10½ gallons at 116°F.; spring No. 3 yields 6½ gallons at 118°F.; and spring No. 4 yields three-fifths of a gallon at 81°F. Spring No. 5 is a slow seepage of water at 107°F.

[2] Knechtel, M. M. *Geology and ground-water resources of the Gila and San Simon valleys, Graham County, southeastern Arizona.* U. S. Geol. Survey Water-Supply Paper (in preparation).

Samples of water were collected from the well and from 3 of the springs (Nos. 1, 3, and 4) and were analyzed by E. W. Lohr of the United States Geological Survey. The analyses, which are given in the accompanying table, show that all the samples contained a comparatively large amount of disolved solids, and that the different mineral constituents were present in each sample in about the same amounts and proportions. The amounts and proportions, moreover, were nearly the same as in a sample of water collected from a flowing

TABLE I.—ANALYSES OF WATERS AT INDIAN HOT SPRINGS AND NEAR PIMA, ARIZONA.[a]

	1	3	4	A	B
Calcium (Ca)	80	78	102	78	73
Magnesium (Mg)	9 4	9.0	12	10	7.2
Sodium and Potassium (Na+K) (calculated)	1,048	1,043	1,182	878	1,190
Bicarbonate (HCO_3)	100	98	114	106	96
Sulphate (SO_4)	405	404	518	357	419
Chloride (Cl)	1,420	1,410	1,580	1,190	1,610
Fluoride (F)	4.1	3.7	4 3	3 3	4 9
Nitrate (NO_3)	.0	.0	5	0	.0
Total dissolved solids (calculated)	3,016	2,996	3,455	2,568	3,351
Total hardness as $CaCO_3$	239	232	304	236	212

[a] Collected November 20–30, 1933 Analysed by E W Lohr Parts per million

1. Spring No. 1; Indian Hot Springs, Eden, Ariz. Temperature 116°F., discharge 145 gallons a minute
3 Spring No. 3; Indian Hot Springs, Eden, Ariz Temperature 118°F ; discharge 6½ gallon a minute
4. Spring No. 4; Indian Hot Springs, Eden, Ariz Temperature 81° F; discharge 3/5 gallon a minute.
A Drilled flowing artesian well ("Beauty Spring"); about 600 feet deep; Indian Hot Springs, Eden, Ariz. Temperature 119°F.; discharge 156 gallons a minute.
B. Drilled flowing artesian well 3,767 feet deep; 1 mile northwest of Pima, Ariz. Temperature 138°F., discharge about 2200 gallons a minute

artesian well with a discharge of about 5 second-feet of water, which was drilled unsuccessfully for oil to a depth of 3,767 feet at a point about 7 miles to the southeast, in the NW¼ NE¼ sec. 13, T. 6 S., R. 24 E., near the town of Pima. Furthermore, though these 5 analyses differ little from each other, they bear much less resemblance to the analyses of samples collected from 44 scattered wells and springs that receive water from sands and gravels at various horizons in the sedimentary deposits of this valley trough.

From the similarity in chemical composition of all the waters collected at Indian Hot Springs and from the Pima well, and the fact that the "Beauty Spring" well water and the water of the 3 springs

that flow most copiously show a variation in temperature of only 2 degrees, it may be inferred that all this water issues from the same horizon. The fact that the water of Nos. 4 and 5 is cooler, and that the water of the Pima well is 20 degrees hotter, than that of the "Beauty Spring" and Nos. 1, 2 and 3 may be explained as follows:

The temperature of spring No. 4 is 35 degrees lower than that of spring No. 1, which is less than 20 feet distant. As these springs yield water of similar chemical composition, which therefore probably comes from the same source, the difference in their temperatures is probably due to the great difference in their rates of flow, the water from spring No. 4 being cooled to a temperature lower than that of spring No. 1 because it rises more slowly to the surface. This implies, of course, that all or a part of the ascent is made through independent openings. This explanation also applies to the temperature of spring No. 5 which is 9 degrees lower than that of spring No. 1.

The temperature of the "Beauty Spring" well water and the water of the three principal springs at Indian Hot Springs averages about 117°F. If it is assumed that the water rises from a depth of only 600 feet, the depth of the "Beauty Spring" well, then unusual local thermal conditions must be invoked to explain the high temperature at this comparatively shallow depth below the surface. It is probable, however, that the water comes to the surface through fractures, perhaps caused by faulting, from an artesian source much deeper than 600 feet and that the well merely taps the upward-moving stream.

A depth-temperature study of field data collected by the writer on 78 flowing artesian wells in the Gila and San Simon valleys was made by H. C. Spicer, of the United States Geological Survey. His computations, which with one exception were based on wells ranging in depth from 100 feet to 1,450 feet, indicate a rise in temperature of 1°F. for each 57 feet of depth. A temperature of 135°F. for a depth of 3,540 feet, as computed from this gradient, checks surprisingly well with the measured temperature (138°F.) of the water flowing from the mouth of the deep well near Pima, most of which rises from a horizon at that depth. Most of the data on the depths of wells, and especially of the deeper wells, used in these computations, were reported to the writer from memory by various persons, some of whom had in turn acquired their information by hearsay. However, they are believed to be fairly reliable as a whole. The water temperatures were those observed by the writer at the mouths of flowing wells and probably are slightly lower than the temperatures of the water at depth. Some heat is lost by the water during its ascent to the surface,

especially in wells that have only small flows, and as many of the wells are not cased, the water issuing from a given well may come from several horizons at which the temperatures differ. In general, however, by far the greatest discharge is from the bottom of the well, and the cooling effect of water from higher levels is small. It is therefore believed that the average temperature, about 117°F., of the water from the 4 principal flowing units at Indian Hot Springs may be taken as a fair indication that the water rises from a depth of about 2,500 feet, this figure being derived from the plotted gradient as worked out by Mr. Spicer from the field data.

The mechanism that forces the water from this depth to the surface may be the same as that suggested to account for the pressure in the numerous artesian wells of this valley. It may be briefly stated as follows: The altitude of the water table in the porous gravels and sands (fig. 2) under the intake area along the margins of the valley is much higher than the surface of the central part of the valley. The pressure of the water in the marginal belts is transmitted underground to vertical openings, such as wells, in the dense lacustrine deposits of the central part of the valley. If the wells are at points where the surface altitude is sufficiently low, artesian pressure will cause discharge of water at their mouths.

BOTANY.—*Two new grasses from the United States and Mexico.*[1]

JASON R. SWALLEN, Bureau of Plant Industry.

Two new grasses have recently been discovered in the United States and Mexico. The first is a new species of *Calamagrostis* collected in Jackson Co., Ohio, by Floyd Bartley and Leslie L. Pontius, and the second is a new species of *Bouteloua* found in Baja California by Forrest Shreve.

Calamagrostis insperata Swallen, sp. nov

Perennis; culmi 85–95 cm alti, glabri, e rhizomatibus erecti; vaginae glabrae, internodiis multo breviores; laminae planae, acuminatae, 10–22 cm. longae, 3–8 mm. latae, glabrae, marginibus scabris; ligula 5 mm. longa; panicula 12–14 cm. longa, ramis adscendentibus; spiculae appressae, 5–5.5 mm. longae; gluma prima lanceolata, 1-nervis; gluma secunda acuta, gluma prima paulo brevior, 3-nervis; lemma 4 mm. longum, 5-nerve, scabrum, apice erosum; pili calli lemmate duplo breviores; rachilla 0.5 mm. longa, pilis 2 mm. longis; arista 1 mm. supra callum inserta, geniculata, circiter 3 mm. longa.

Perennial; culms 85–95 cm. tall, erect, glabrous, with slender creeping rhizomes; sheaths much shorter than the internodes, smooth or scaberulous;

[1] Received June 14, 1934.

blades flat, acuminate, 10–22 cm. long, 3–8 mm. wide, glabrous, the margins scabrous; ligule membranaceous, about 5 mm. long; panicles 12–14 cm. long, the branches narrowly ascending, at least some of them naked toward the base, the lower ones as much as 5 cm. long; spikelets appressed to the branches, 5–5.5 mm. long; glumes unequal, somewhat keeled, scabrous on the keels, the first lanceolate, 1-nerved, the second acute, 3-nerved; lemma 4 mm. long, 5-nerved, scabrous, the narrow tip erose; callus hairs moderately dense, the lateral ones about half as long as the lemma, those on the back of the callus shorter; prolongation of the rachilla 0.5 mm. long, the hairs 2 mm. long; awn inserted about ¼ above the base, equaling the lemma, twisted below, geniculate, protruding from the glumes at maturity.

Type in the U. S. National Herbarium no. 1,611,713. Collected in Ofer Hollow, Liberty Township, Jackson Co., Ohio, August 1, 1934, by Floyd Bartley and Leslie L. Pontius.

This species is closely related to *C. pickeringii*, in which the spikelets are only 4–4.5 mm. long, the callus hairs are scant, and the rachilla hairs are only 0.5 mm. long.

Bouteloua annua Swallen, sp. nov.

Annua; culmi dense caespitosi, erecti, basi geniculati, 3–25 cm. alti, glabri, ramosi; vaginae internodiis breviores; laminae planae, acutae, 1–3.5 cm. longae, 1.5–2 mm. latae, pubescentes vel glabrae; ligula ciliata, 0.2 mm. longa; spicae 2–7, 1.5–2 cm longae; spiculae 8–10 mm. longae, non pectinatae; gluma prima 1-nervis, 3.5–7 mm. longa, angusta; gluma secunda 6–9 mm longa, 1-nervis, lata; lemma fertile, gluma secunda paulo longius, 3-nerve, 3-dentatum, dentibus 2 mm. longis; flos imperfectus pilosus, aristis 3 scabris.

Annual; culms densely tufted, erect or geniculate spreading at the base, 3–25 cm. long, glabrous with a single branch from the middle node; sheaths shorter than the internodes, glabrous; blades flat, 1–3.5 cm. long, 1.5–2 mm wide, acute, pubescent on the upper surface or nearly glabrous; ligule ciliate, 0.2 mm. long; inflorescence as much as 8 cm. long with 2–7 rather distant ascending to spreading spikes, these falling entire; spikes distant, 1.5–2 cm long, bearing 4–7 usually appressed spikelets, the rachis produced beyond the uppermost spikelet; spikelets 8–10 mm. long, appressed, green or usually purple, with one fertile floret and a 3-awned rudiment; glumes 1-nerved, more or less scabrous on the nerves, otherwise glabrous, the first 3.5–7 mm. long, very narrow, the second 6–9 mm. long, much broader, inclosing the florets; lemma a little longer than the second glume prominently 3-nerved, 3-toothed, the teeth about 2 mm. long, sparsely appressed pilose in lines especially close to the nerves, the callus densely pubescent; rudiment somewhat exceeding the lemma, the base stout, pilose, the awns scabrous.

Type in the U. S. National Herbarium no. 1,611,715. Collected 4 miles east of San Ignacio, Baja California, March 6, 1935, by Forrest Shreve.

This species belongs to the section *Atheropogon*, in which the spikes fall entire from the main axis and the spikelets are not pectinately arranged. Two other annual species, *B. alamosana* and *B. aristidoides*, belong to this group. The first differs from *B. annua* in having tuberculate hairy foliage,

and shorter spikes (10–15 mm. long), the spikelets closely appressed to the rachis. The second differs in having very slender spreading spikes with distant appressed spikelets. *B. annua* resembles *B. filiformis* in the form of the inflorescence, but that species is strictly perennial.

ZOOLOGY.—*A restudy of* Filariopsis arator *Chandler, 1931, with a discussion of the systematic position of the genus* Filariopsis *van Thiel, 1926.*[1] Everett E. Wehr, Bureau of Animal Industry. (Communicated by Eloise B. Cram.)

Van Thiel (1926)[2] proposed the genus and species *Filariopsis asper* for nematodes collected from the lungs of a "roaring monkey" (*Mycetes seniculus*) by Dr. C. Bonne in Surinam, British Guinea. Five years later, Chandler (1931)[3] described a second species *F. arator* for nematodes collected from the lungs of a South American monkey (*Cebus* sp.) by Dr. W. H. Taliaferro in Chicago, Illinois. Van Thiel referred the genus *Filariopsis* to the superfamily Filarioidea without assigning it to a family. Chandler, however, created the family Filariopsidae solely for its reception.

The present writer has made a restudy of the type specimens of *Filariopsis arator* Chandler, 1931. The results of this study have made it necessary to revise the original description of this species in certain respects. It has also made it possible to include a discussion of the cephalic papillae which have not been described in the literature.

RESTUDY OF FILARIOPSIS ARATOR

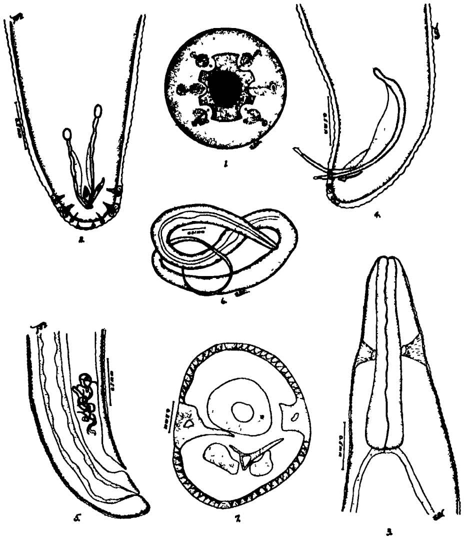
In the original descriptions it was stated that the oral opening was surrounded by 3 either "conspicuous" (*F. asper*) or "very inconspicuous" (*F. arator*) lips. According to the present writer, the head of *Filariopsis arator* is provided with 2 lateral trilobed lips (Fig. 1) on which are located a number of papillae. These papillae, numbering 14 in all, are divided, according to their mode of innervation, into 2 circles: An external circle of 8 papillae arranged in 4 groups of 2 papillae each, of which the dorsodorsals and ventroventrals are slightly smaller than, and situated internal to, the laterodorsals and lateroventrals; and an internal circle of 6 papillae, consisting of 1 papilla on the anterior border of each of the 6 lobes of the 2 trilobed lips. The amphids are located posterior to the internolateral papillae.

[1] Received June 7, 1934.

[2] Van Thiel, P. H. *On some filariae parasitic in Surinam mammals, with the description of* Filariopsis asper *n. g., n. sp.* Parasitology 18: 128–136. 1926.

[3] Chandler, A. C. *New genera and species of nematode worms.* Proc. U. S. Nat. Mus., (2866), 78: 1–11. 1931.

The anterior extremity of *F. arator* (Fig. 3) was not figured by Chandler, but it is similar to that of *F. asper* as figured by van Thiel.



Figs. 1-7.—*Filariopsis arator*. Fig. 1.—Head, *en face* view. Fig. 2.—Male tail, ventral view. Fig. 3—Anterior extremity, dorsoventral view. Fig. 4—Male tail, lateral view Fig. 5.—Female tail, lateral view. Fig. 6.—First-stage larva Fig. 7.—Cross section of body just back of excretory pore, showing excretory canal and the 2 subventral excretory cells on each side of it.

The clavate esophagus is short and muscular, and the broad, thick-walled intestine contains multinucleated cells. Two subventral ex-

cretory cells extending from the excretory pore posteriorly along each lateral side of the excretory canal were found in *F. arator*.

The caudal extremity of the male was described and figured by Chandler as lacking caudal alae and caudal papillae. Present observations indicate that alae are apparently absent or very poorly developed, and that there are 7 pairs of caudal papillae (Figs. 2 and 4) arranged in 4 groups and situated along the lateral and posterior margins of the body. The most anterior group on each side is composed of 2 papillae, the next of 3 papillae, and the last 2 groups 1 papilla each. Each papilla is joined to the body proper by a very weakly developed bursal ray. In the 2 male specimens available for study, the 2 approximately equal spicules do not appear to be joined together by a membrane, but each spicule is provided on its inner border with a wing-like membrane extending for about the middle two-thirds of its length. The so-called gubernaculum, boat-shaped in ventral view, appears in lateral view as an elongated cutinous plate with the distal end presenting a hook-like structure on its lower surface.

The vulva of the female of *F. arator* (Fig. 5) is located just anterior to the anal opening; that of *F. asper* occupies a similar position, according to van Thiel.

The first-stage larva (Fig. 6) is about 300μ long and 10 to 11μ wide, with the anterior end slightly attenuated and the tail very long, slender, and pointed at the tip. The esophagus extends about ⅛ the total length of the body, with a swelling near the equator and another at the posterior end. In general body form, the first-stage larva of *F. arator* is similar to that of *F. asper*.

As a result of the present morphological study there seems to be no reason to believe, as Chandler did, that the 2 above species may eventually have to be placed in different genera. The male of *F. asper* has been described by van Thiel as possessing small caudal alae and 5 pairs of caudal papillae; it differs from that of *F. arator*, therefore, chiefly in the number of caudal papillae, since, according to van Thiel's figure of the male tail of *F. asper* the caudal alae, if present at all, are much reduced. Both species have similar spicules; *F. asper*, however, is described as having 2 gubernacula and *F. arator* as having only one.

SYSTEMATIC POSITION OF THE GENUS FILARIOPSIS VAN THIEL, 1926

Van Thiel did not state the reasons for his conclusion that the genus *Filariopsis* possesses filarioid affinities. As one of the characters of this genus, he mentioned the presence of microfilariae and, in all

probability, his belief that the young of this species were true microfilariae caused him to allocate this genus to the Filarioidea. None of the other characters of this genus mentioned by van Thiel, namely, (1) cuticle covered with conical protuberances, (2) situation of vulva close to anus, and (3) equality of 2 spicules, suggest filarioid affinity as the superfamily Filarioidea is defined today. Chandler debated whether to place the genus *Filariopsis* in the Spiruroidea or the Filarioidea, but finally decided tentatively to include it in the Filarioidea because of the absence of paired lips, the long and slender body, the position of the adults in the lungs of the host, and the presence of "microfilaria-like" embryos in the uteri, although, as he said, the genus differs from the other members of the Filarioidea in having the vulva near the anus, in the short muscular esophagus, and in the "non-coiled tail of the male."

As a result of his recent study of *F. arator*, the present writer has come to the conclusion that the genus *Filariopsis* belongs to the Metrastrongyloidea rather than to the Filarioidea. This conclusion is based on the following findings: The microfilaria-like embryos referred to by Chandler and van Thiel are not true microfilaria as they possess a distinct esophagus with 2 swellings, one near the equator and the other at the posterior end; the presence of 2 subventral excretory cells and of multinucleated intestinal cells in the adult (the present writer has demonstrated the presence of similar cells in *Metastrongylus elongatus*), and the character of the adult esophagus and the male tail. The presence of subventral excretory cells is a characteristic of the Strongylata, according to unpublished observations made by Dr. B. G. Chitwood, Zoological Division, Bureau of Animal Industry. The polymyarian condition of the somatic musculature, the absence of longitudinal cuticular markings, and the character of the esophagus of the first-stage larva tie *F. arator* to the Metastrongyloidea, and the much reduced bursa and bursal rays allocate it to the family Pseudaliidae and the subfamily Filaroidinae.

SUMMARY

A restudy of the type specimens of *Filariopsis arator* Chandler, 1931, has made it possible to add to the previous description of this nematode. From this new evidence and a critical analysis of the earlier descriptions of *F. arator* and *F. asper*, it is concluded that the genus *Filariopsis* belongs in the superfamily Metastrongyloidea, family Pseudaliidae, subfamily Filaroidinae.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

1073RD MEETING

The 1073rd meeting was held in the Cosmos Club Auditorium, October 27, 1934, President DRYDEN presiding. On a motion proposed by the Reverend HAWKESWORTH, which was unanimously approved, the recording secretary was instructed to convey to PAUL R HEYL, a past president of the Society, the Society's condolence and deep sympathy because of the accident he suffered, October the twentieth.

The program consisted of two addresses upon the stratosphere flight of the *Explorer*.

L. J. BRIGGS: *The flight of the stratosphere balloon* Explorer —The stratosphere flight on July 28 was sponsored by the National Geographic Society and the Army Air Corps. The great spherical balloon had a capacity of 3,000,000 cubic feet—three times as large as any balloon heretofore constructed and was designed to reach an altitude of 75,000 feet. The gondola, 100 inches in diameter, carried about a ton of apparatus and equipment.

The principal objectives were: (1) the measurement of the ionization produced by cosmic rays at different altitudes; (2) the directional effect of cosmic rays; (3) the spectrographic determination of the position of the ozone layer and the far ultraviolet spectrum of the sun; (4) the collection of air samples from the stratosphere; and (5) the determination of the relationship between altitude (computed from photographs with a vertical camera) and air density (computed from the observed pressure and temperature).

The ascent was made from a natural bowl in the Black Hills, chosen to provide protection from wind during inflation. All the apparatus functioned perfectly. The ascent was stopped at 61,600 feet because rips appeared in the bottom of the balloon. A slow descent was begun, and at 18,000 feet the gondola was opened. The descent continued at about 12 feet per second, but the tearing of the lower fabric increased until finally the entire bottom of the balloon below the catenary tore away. The flight personnel decided to try to land the balloon as a parachute, but at 3,000 feet the balloon suddenly disintegrated. Major Kepner, Capt. Stevens, and Capt. Anderson took to their parachutes and the gondola went crashing into the ground.

Reliance had been placed largely on photographic recording of the observations. All cameras were broken open by the impact, but the films which remained tightly rolled, although badly light-struck, were found to be legible up to the highest altitude of the flight. The sun spectrograph, suspended below the gondola, had been cut loose before the balloon failed and landed safely on its own parachute. Consequently, much information was gained from the flight, despite its unfortunate ending. (*Author's abstract.*)

L. B. TUCKERMAN: *Technical difficulties in stratosphere ballooning.*—The technical difficulties in stratosphere ballooning in contrast to ordinary ballooning depend upon the greatly increased pressure differences encountered. First, the decrease in density of the air, which is on the average somewhat more than ½ for each 20,000 feet of altitude, requires very much larger balloons to carry the same load. The necessity of maintaining sufficient air

pressure to keep the passengers alive increases the necessary dead weight and still further increases the necessary size of the balloon.

The large size makes net balloons impractical so that in stratosphere balloons, as in racing balloons, the gondola is hung from a catenary suspension band instead of from a net. The great size, however, prevents the use of an inflation net, as is customary in racing balloons. This is replaced by an upper catenary band controlled by yaw ropes during inflation.

The great decrease in pressure also makes it impractical to fill the balloon completely at the ground level. The gas in the balloon would expand somewhere between 22 to 28 times its volume in rising 75,000 feet instead of approximately twice as it would if the balloon were to rise to only 20,000 feet. It is customary to provide for a loss of approximately ⅙ of the gas volume at the maximum so that the balloon at the take-off is only approximately 1/15 full.

The technique of folding and inflating the balloon must therefore be such as to allow the balloon to fill out during the ascent without undue stresses occurring in the fabric. Two techniques have been used.

In the open bottom technique the requisite amount of hydrogen is put in the bag and air allowed to enter as the yaw ropes are eased off, so that at the time of take-off the air inside the lower portion of the bag is in pressure equilibrium with the air outside. This facilitates a smooth arrangement of the bag but has the disadvantage of the constant menace of a hydrogen-air explosion.

In the closed bottom technique no air is admitted, so that the whole lower portion of the balloon is collapsed and held tightly together under the excess pressure of the outside air. This makes it difficult to arrange the folds of the balloon smoothly, especially the lowest portion between the suspension ropes. To avoid this difficulty in the *Explorer* the lowest portion was folded inside the portion above the suspension band, making the inflation of the balloon much easier. Unfortunately this allowed the transmission of excessive local stresses from the outer fabric to the inner fabric through the shear resistance of adhesions. These stresses produced multiple radial tears in the lower portion of the balloon. In future flights, this difficulty can be avoided in several ways, the particular method to be used depending upon estimates of cost

The *Explorer* descended as an open bottom balloon. The explosion which destroyed the balloon at about 2500 feet from the ground emphasizes the danger inherent in the open bottom technique.

With present ballooning technique it does not seem feasible to reach altitudes much above 90,000 or perhaps 100,000 feet. Rough estimates indicate that to carry the scientific apparatus and the gondola of the *Explorer* to a height of 100,000 feet would require a balloon of over 25,000,000 cubic feet and that over 7500 lb. of ballast would need to be retained at its maximum altitude to bring the balloon down safely.

To reach 150,000 feet the estimates give the fantastic figures of over 2,000,000,000 cubic feet, a balloon of over 1500 feet in diameter, carrying over 125,000 lb. of ballast. These estimates, based upon present balloon practice and our imperfect knowledge of the atmospheric conditions above 75,000 feet, can of course only indicate orders of magnitude. However, no feasible modifications in balloon technique seem to offer materially smaller figures. (*Author's abstract.*)

There was a joint discussion of these addresses participated in by Messrs. Hawkesworth and W. P. White.

1074TH MEETING

The 1074th meeting was held in the Cosmos Club Auditorium, November 10, 1934, President DRYDEN presiding.

Program: R. E. GIBSON: *Compressibility of aqueous solutions.*—Measurements of the compressibility of aqueous solutions made at the Geophysical Laboratory were presented and these were correlated by means of the following relation: the change in volume upon compression of an aqueous solution is equal to the sum of two volume changes: first, that of the pure solute under the externally applied pressure, and second, that of pure water initially under a so-called *internal pressure* when subjected to a further increase of pressure equal to the applied pressure on the solution The *internal pressure* is proportional to the volume concentrations of the water and solute. (*Secretary's abstract.*)

Discussed by Messrs. HAWKESWORTH, MOHLER, WHITE, KRACEK, ADAMS, HECK, and BRICKWEDDE.

L. R MAXWELL: *Electron diffraction and its application to the structure of molecules.*—Recent advancements in the field of electron diffraction were presented The experiments on the diffraction of electrons from thin metallic foils and diatomic gases were shown to be in agreement with the theories of electron scattering. This justifies the use of electron diffraction for the determination of the structure of complex molecules Examples of this kind were given for NO_2 and N_2O_4 From a treatment of the molecule 1, 2 diiodobenzene clear physical evidence was shown for the phenomenon of *steric hindrance* The relation between the C-C distance and strength of bond was given and also the values of the C-C distances characterized by aliphatic and aromatic compounds. Brief summary of all structure determinations by electron diffraction was presented (*Author's abstract.*)

Discussed by Messrs GIBSON and BRIGGS.

Informal Communications: L. B TUCKERMAN.—Debye and Sears showed that standing high frequency acoustic waves in a transparent medium acted like a grating. Schaefer and Bergmann set up waves simultaneously in three different directions mutually at right angles, thus setting up a *space lattice* of concentrations of stress Passing ordinary light waves through the medium either liquid or solid, produces a *Laue pattern.* Slides copied from the following published articles were shown: C. Schaefer u. L Bergmann: *Laue-Programme mit optischen Wellen.*—Sitz Ber. Preuss. Akad d Wiss, X: 152–153, March 22, 1934, and *Neue Interferenzerscheinungen an schwingenden Piezoquarzen.*—l. c., XIII–XIV, April 26, 1934. (*Author's abstract.*)

W. J HUMPHREYS and H. L. DRYDEN.—This dealt with the orientation of falling hexagonal, columnar crystals of ice in air, that is, with the question as to whether the crystals falling with the long axis of the column horizontal fall with the long diagonal of the hexagon horizontal or vertical. The solar halo called the Peary Arc is produced by crystals oriented with the long diagonal of the hexagon horizontal Wind tunnel tests on a wooden model showed that the most stable position for the model was that with the long diagonal in a direction corresponding with the vertical (*Secretary's Abstract.*)

Discussed by Messrs. NCNISH and MAXWELL.

1075TH MEETING

The 1075th meeting was held in the Cosmos Club Auditorium, November 24, 1934, President DRYDEN presiding.

The program consisted of three papers dealing with different phases of

Finding the fact about strong earthquake motion with special relation to its effect on structures.

N. H. HECK: *Outlining the problem.*—In designing buildings to resist earthquakes some assumptions have been made which should be tested in the light of present knowledge. The adoption of an acceleration of 0 2 or 0.1 g. as a true measure of a great earthquake was shown to be merely a guess that works for reasons not directly connected with the earthquake The range of 0.5 to 2 5 secs, as that of dangerous periods of buildings, with the inference that other periods are not dangerous, was shown to be probably due to the fact that this range covers the periods of most of the buildings in Japan where the idea was suggested and the effect is simply resonance.

Earthquakes have a very wide range of periods and it is not possible to design a building to escape a period which may set it into resonance. However if the ground can be set into vibration in its own period then there will be prevailing periods in any earthquake which can and should be avoided. Observations of ground period at Göttingen, Germany, by means of a machine which sends controlled vibrations through the ground showed that definite periods exist. The results were checked by observations of seismograms from earthquakes a few hundred miles away, by explosions and by study of microseisms.

The investigations in California include strong motion measurements which have been made as the result of eight earthquakes in California and two in Nevada In the case of one of the latter as well as in one in Panama the instrument was about 200 miles from the earthquake epicenter. The instruments are placed in the basements of buildings, in the top or elsewhere in buildings. Accelerographs and displacement meters are operated together. The result is a wide range of records obtained under varying conditions.

The investigations also include measurement of vibration periods of buildings, tanks, bridge piers and dams; the measurement of ground periods by controlled vibrations and by analysis of earthquake records, including strong motion; the study of earthquake damage in the Long Beach earthquake of March 10, 1933; and the development and construction of instruments needed to accomplish these purposes.

The program was developed at a series of conferences in California last spring which resulted not only in an effective and broad plan, much of which is now in operation, and also arrangements for application of the information to building design, a field into which the Coast and Geodetic Survey does not enter. The organizations represented include the organizations of structural, civil and mechanical engineers, and several universities interested in the work. (*Author's abstract.*)

H. E. McCOMB: *Development of instruments.*—Instruments which have been developed elsewhere for use in areas frequented by strong earthquakes were found to be unsuitable for the particular problems in hand. Hence, the program called for much preliminary testing of crude designs, preparation of plans and specifications for completed instruments and equipment on a quantity basis and study of all other phases of the project which would involve continuous operation and maintenance of a large number of instruments at great distances from Washington. As a result of rather intensive application the Coast and Geodetic Survey had in operation on the Pacific Coast, thirty-three 3-component accelerographs, six displacement meters and eleven low-magnification mechanical seismographs. One accelerograph

is also in operation in the Canal Zone. In addition to the seismographic equipment three interferometric tiltmeters, for use in studying pre-seismic tilting effects of the ground, have been installed in the vicinity of well-known faults.

Instruments and other accessories have been altered, in many cases, quite radically, when, after extensive tests, it has been proved that much would be gained in simplicity, convenience of adjustment and interchangeability of parts without sacrificing accuracy or reliability. The most radical change was from quadrifilar accelerometer suspension to pivot and helical spring suspension. In addition to this improvement there has been designed a low-magnification attachment for the accelerometers which permits any single unit to record at normal magnification and also simultaneously at about ⅙ normal on the photographic recorder, the spots being in the same phase and free from parallax. Actual records obtained at Long Beach show that this reduced magnification should simplify interpretation of the main record and will insure full registration of the most severe earthquakes.

Instruments, resembling in many respects, standard Wood-Anderson seismometers, have been constructed for use in studying building vibrations. Shaking tables for use in testing the vibration meters have been designed and are under construction At Pasadena, Dr. Benioff of the Carnegie Institution of Washington is cooperating in the program by constructing some electromagnetic seismographs for use in studying effects of aftershocks. He has also constructed a series of simple recording pendulums of different natural periods operating side by side At Stanford University, Dr. Jacobsen has constructed a device for placing buildings or the ground into vibration for convenient study by vibration meters.

About 40 slides were shown and several instruments of recent design were exhibited (*Author's abstract*)

FRANCK NEUMANN: *Analyzing the records.* -The engineer expects about five different classes of data as a result of the present seismological investigations now being undertaken by the U. S Coast and Geodetic Survey in California. They are: (1) Periods of earthquake waves, (2) Natural vibration periods of geological formations in seismic areas, (3) Periods of buildings, (4) Motion of the ground during an earthquake in terms of acceleration and displacement, and (5) Motions of the upper floors of structures during an earthquake.

Periods of earthquake waves are obtained by direct measurement on strong motion seismograms, as the pendulum of a seismograph is forced to swing in the period of the wave, but amplification on the record varies greatly, depending upon the ratio of the earth wave period to the pendulum period. The periods of geologic formations are observed by studying the dominant periods on seismographic records, or by forcing the ground to vibrate artificially with an agitator or unbalanced wheel In the latter case the largest amplitudes are recorded on a sensitive seismograph when the period of the agitator tunes in with the natural period of the formation Building periods are obtained by observing with a sensitive seismograph the natural swaying of a structure caused by wind or an agitator. The period of a building is dependent not only on the physical properties of the structure itself, but also on a foundation factor or *hinge* effect. J Creskoff has shown theoretically that the fundamental period and its ratio with the first overtone vary with the type of foundation. Period observations, therefore, furnish directly information which is necessary in computing the period of a structure. The aim of the engineer is to design structures which

will not tune in with the most prevalent earth wave periods during an earthquake, or with the natural vibration periods of the geological formations on which they are built.

Ground movements during an earthquake are measured with displacement meters and accelerometers. The problem of analyzing the records is greatly simplified by assuming sustained simple harmonic motion of the earthquake waves over small portions of the record, and by using a so-called harmonic magnification curve. The latter shows the ratio between the displacement of a seismograph pendulum (with respect to the moving ground) and the actual displacement of the ground itself. In a displacement meter the earth wave periods are relatively short with respect to the pendulum period so that the mass remains almost fixed in space while the ground moves beneath it In the accelerometer the harmonic magnification terms become practically equal to the ratio of the square of the pendulum period over the earth wave period, and when this is substituted in the expression for simple harmonic acceleration, the earth wave periods are eliminated, showing that acceleration is independent of the earth wave period. Pendulum periods in an accelerometer must be less than one-third of the periods of the earth waves to be measured.

Building movements are measured in the same manner as ground movements. Experience teaches that the top of a moderately tall building may sway through seven times the amplitude of the ground during an earthquake.

When simple harmonic motion cannot be assumed the records must be integrated to obtain true ground motion. Work has been done in double integrating acceleration curves to obtain displacement with some success, but the deflections of the acceleration trace are so small for the longer period earthquake waves that the task becomes extremely difficult. The accelerogram is magnified about eight times by means of a lantern projector and the image traced with a pencil on coordinate paper The average ordinate is tentatively accepted as the axis and the integration carried through. From the dimension of the bend in the resulting double integrated curve, the errors in the acceleration and velocity curves can be computed, and the work is then repeated so the final curve lies along a straight axis. The work of integration is done on standard adding machine. (*Author's abstract.*)

There was a joint discussion of the three papers participated in by Messrs. H. L. CURTIS, McNISH, HECK, HUMPHREYS, DRYDEN, BRICKWEDDE, and WENNER.

1076TH MEETING

The 1076th meeting, constituting the 64th annual meeting, was held in the Cosmos Club Auditorium, December 8, 1934, President DRYDEN presiding.

The treasurer reported receipts of \$3669 47 including the payment of a real estate note amounting to \$1500.00, and expenditures of \$2333 40 including the purchase of a bond amounting to \$1024.82, leaving a cash balance of \$1336.07 The treasurer's report showed an active membership of 299.

The secretaries reported that the following new members were elected during the year: A. K. BREWER, C. F. BROWN, P. CHRZANOWSKI, W. E. DEMING, J. M. FRANKLAND, R E. GEBHARDT, L. C. GOTTSCHALK, R. B. HOBBS, H. H. HOWE, E. A. JOHNSON, R. T. MILNER, M. M. MUNK, J. A. PLUGGE, P. A. SMITH, R. WIEBE, P. H. WILLIAMSON, and O. R. WULF.

The following deaths were reported: R. Y. FERNER, G. O. SQUIER, and G. F. STROHAVER.

The following officers were declared elected for the year 1935: *President*, O. H. GISH; *Vice Presidents*, N. H. HECK and F. WENNER; *Recording Secretary*, L. R. HAFSTAD; *Treasurer*, R. E. GIBSON; *Members-at-large of the General Committee*, F G. BRICKWEDDE and H E McCOMB.

During the year the fourth Joseph Henry Lecture, in memory of the first president of the Philosophical Society, was given by Professor OSWALD VEBLEN of the Institute for Advanced Study, Princeton, N. J.

At the conclusion of the business part of the program, Mr W J. HUMPHREYS presented a paper, illustrated by slides, entitled *Tall tales of the prairie twister*. Following the presentation of the paper there was a discussion participated in by Messrs. DRYDEN, CURTIS, HECK, HAWKESWORTH, WAIT, MARIS, ROESER, HAZARD, SHEPHERD, SILSBEE, TUCKERMAN, GISH, and four others unknown to the secretary.

(*Author's abstract*).—The tornado, a violent rotating wind starting at the cloud level and burrowing down to the earth, occurs more frequently in the United States, mainly in the Mississippi Valley, than in any other country. It appears to be caused by vertical convection at the boundary between oppositely-flowing masses of air, turns counterclockwise in the Northern Hemisphere, clockwise in the Southern, and leaves a sharply-defined path of destruction

It is exceedingly noisy, even when away from contact with the earth, and its power of destruction, owing partly to the velocity of the wind and partly to the decrease of pressure in the vortex, is astonishingly great. The dominant effects of the tornado are wreck and ruin, but also many surprising things occur Trees, houses, and bridges may be utterly demolished, and yet out from the welter of destruction delicate and easily breakable things may be carried miles away without harm

In one case a steel beam, one of the supports of a bridge, was torn from its setting and hurled an eighth of a mile where, end on, it struck a tree and penetrated clear through it, 20 feet above the ground Amazing weights are lifted, concrete posts pulled out of the ground, and even locomotives and heavy steel coaches thrown from their tracks. Planks are stuck into the ground like fence posts, driven through trees and even, in one case, through the thick steel web-plate of a bridge.

And sometimes there seems to be a bit of grim humor in what the tornado does. It sticks straws end on into trees and leaves us the puzzle of explaining how; pulls the wool from a sheep's back with never a break in his skin; makes boastful roosters silent members of the flock, with every feather gone; and a man, woman or child it may leave unscathed on a neighbor's lawn with never so much of the conventional dress as even a chemise or shirt.

Unfortunately the great majority of the tales of the tornado, the smallest but most violent of all storms, are tales of tragedy; yet some are humorous, even ludicrous, while many are indeed *tall*, in the sense of surprising.

F. G. BRICKWEDDE, *Recording Secretary*

SCIENTIFIC NOTES AND NEWS

Prepared by Science Service

Notes

Biological Survey's Golden Jubilee.—Fifty years ago, in 1885, a modest appropriation of $5,000 by Congress for the promotion of "economic ornithology," marked the first beginnings of the activities that have come to be centered in the Biological Survey of the U. S. Department of Agriculture. Upon the recommendation of the American Ornithologists' Union, Dr. C. HART MERRIAM, physician and naturalist, was appointed head of the new project, with which he served until his retirement in 1931. The project was first established as a branch of the Division of Entomology. The year following, with a doubled appropriation, it achieved independent status as the Division of Economic Ornithology and Mammalogy. In 1896, the name was changed to Division of Biological Survey, and in its twentieth anniversary year, 1905, it received its present title of Bureau of Biological Survey.

Secretary HENRY A. WALLACE and JAY N. DARLING, chief of the Bureau, were among the speakers at the thirteenth annual convention of the Izaak Walton League of America in Chicago last spring. A number of members of the Survey also participated.

AMOS B. EMERY has been designated to coordinate and direct the work of some 25 CCC camps on refuges administered by the Survey.

By Act of Congress, approved by the President on June 15, any person is authorized to purchase migratory bird hunting stamps. A waterfowl hunter must have in possession a stamp that has been validated by writing his signature across its face The same Act carried an appropriation of $6,000,000 to be used for the acquisition of lands for refuge purposes. Funds from the Emergency Act of April 8, 1935, may also be allocated by the President for refuge-acquisition purposes.

Food and Drug Administration.—Two Doctors NELSON have been appointed as chiefs of new divisions of the Food and Drug Administration, Dr. E. M. NELSON as chief of the Vitamin Division and Dr. ERWIN E. NELSON as chief of the Pharmacological Division. The Department of Agriculture announced that each is now assembling a staff taken in part from older units of the Department and in part recruited from specialists in the sciences involved in the work of the new divisions. The Vitamin Division will check the claims and help establish standards for food and drugs for which claims of vitamin potency are made. The Food and Drug Administration has been doing some routine work of this sort, but it has been inadequate to meet the growing need. The Pharmacological Division in addition to more comprehensive testing of certain medicinal products, will pay particular attention to several relatively new fields of work—the testing and standardization of glandular preparations put on the market in recent years, investigations of the effect of poisons and impurities present in foods, and testing of the effects of new synthetic chemicals used in foods and medicines. Of the poisons and impurities, the question of spray residues on fruits and vegetables is now most pressing In regulating interstate commerce in sprayed products the department is urgently in need of more positive and authoritative guides to safe practice.

National Park Service.—Chief Naturalist EARL A. TRAGER during August

made a geological inspection tour of the states north of the District of Columbia. Included in his itinerary were visits to several of the state parks in Pennsylvania and New York, the Acadia National Park in Maine, and a tour of the section which would be traversed by the proposed Green Mountain Parkway.

VINCENT W. VANDIVER of Missouri has received appointment as regional geologist for the National Park Service. His headquarters will be Washington, D. C., and he will probably be assigned to the region including the states of Nevada, Arizona, New Mexico and Utah. Before coming to the Park Service he was a member of the Missouri Geological Survey.

SUMNER M. ANDERSON of New York and Dr ROY A. WILSON of Oklahoma have also been assigned to work in connection with the Service's geological program. Mr. ANDERSON has made extensive geological studies in South America, and the middle section of the United States. Dr. WILSON has served as professor of geology at the University of Oklahoma. It is planned to assign him to the Rocky Mountain region.

National Bureau of Standards.—Dr. MORTON G. LLOYD attended sessions of the International Electrotechnical Commission at the Hague and Brussels June 18 to 27, and sessions of the International Commission on Illumination at Berlin and Karlsruhe July 1 to 10 He also attended the National Electrical Convention of Great Britain held at Bournemouth early in June.

Dr. F. C. BRECKENRIDGE attended the sessions of the International Commission on Illumination at Berlin and Karlsruhe July 2 to 10 and is spending some time in Europe inspecting facilities for air transport, particularly lighting and light signals Mr. BRECKENRIDGE is in charge of a group of men engaged on study of such problems on behalf of the Bureau of Air Commerce and the Navy Department, and the primary purpose of his trip is to obtain information of value to those organizations.

Dr. LYMAN J. BRIGGS, director of the National Bureau of Standards, presided at a meeting in Akron, Ohio, on July 24 of a special board of inquiry called for the purpose of ascertaining the cause of failure of the stratosphere balloon Explorer II. The board is composed of representatives of the National Geographic Society, Army Air Corps, and members of various scientific societies and the National Bureau of Standards.

Department of Terrestrial Magnetism.—Dr. E H. BRAMHALL, physicist of the Byrd Antarctic Expedition II, has been appointed professor of physics at the University of Alaska to succeed Prof. VERYL R. FULLER, who died suddenly on May 30. Since June 10, Dr. BRAMHALL has been engaged at the Department of Terrestrial Magnetism of the Carnegie Institution of Washington in making the final comparisons with standards and in determining constants and corrections for the instrumental outfit used during the Byrd Antarctic Expedition II, and in the development of the technique for the ionospheric program at College, Alaska, which he will continue when he takes up his duties there.

Dr. J. BARTELS, professor of physics at the Forstliche Hochschule, Eberswald, Germany, and lecturer in geophysics at the University of Berlin, and Dr. S. CHAPMAN, chief professor of mathematics at the Imperial College of Science and Technology, London, England, both research associates of the Carnegie Institution of Washington, are spending the summer in America, chiefly at the Department of Terrestrial Magnetism, engaged on research problems in geophysics.

News Briefs

By executive order of the President, the Science Advisory Board has been continued until December 1, 1935.

A device for the rapid sectioning of hair, wool and other fibers, to facilitate microscopic examination, has been invented by Dr. J. I. Hardy of the Bureau of Animal Industry, U. S. Department of Agriculture. In addition to its primary usefulness in fiber technology, it may find employment in the Federal Bureau of Investigation, U. S. Department of Justice.

The Smithsonian Institution has published a description of the Badianus Manuscript (Vatican Library), which is the earliest known American Herbal. It was written in Mexico City in 1552, in Aztec, by an Aztec Indian student at the College of Vera Cruz, and was translated into Latin by another Aztec Indian.

Obituary

Marion Dorset, chief of the Biochemic Division, Bureau of Animal Industry, U. S. Department of Agriculture, died at his home in Washington, D. C., July 14, 1935, after a brief illness. He was born December 14, 1872, in Columbia, Tennessee. After graduating from the University of Tennessee in 1893, with the degree of Bachelor of Science, he attended the University of Pennsylvania for a year Dr. Dorset then entered the U S. Department of Agriculture as assistant chemist. While there he continued his scientific education at George Washington University, receiving the degree of Doctor of Medicine in 1896. Eight years later he became chief of the Biochemic Division of the Bureau of Animal Industry, a position he held until his death. The honorary degree, Doctor of Veterinary Medicine was awarded in 1915 by Iowa State College

Although known especially for his research studies of hog cholera and his discovery of an effective preventive serum treatment for this devastating scourge, Doctor Dorset made many other important scientific contributions covering a wide field. They included research studies on the tubercle bacillus, keeping qualities of meats, composition and nutritive value of various meats and meat food products, the development and testing of disinfectants and dipping preparations, biological products used against animal diseases, research in dairy bacteriology, and extensive related work. Dr. Dorset organized the Federal inspection of establishments licensed to manufacture serums, viruses, toxins, and related veterinary biological products He likewise formulated the laboratory procedures in the administration of the Federal Meat Inspection Act. As its first chairman Dr. Dorset organized the Insecticide and Fungicide Board and in collaboration with the other members initiated enforcement of the Insecticide Act of 1910. In addition to the Washington Academy of Sciences he was a member of the American Chemical Society, the Society of American Bacteriologists, the American Public Health Association, a fellow of the American Association for the Advancement of Science, and an honorary member of the American Veterinary Medical Association.

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SEISMOLOGY.—*Earthquakes associated with the 1934 eruption of Kilauea, Hawaii.*[1] AUSTIN E. JONES, U. S. Geological Survey. (Communicated by T. A. JAGGAR.)

This paper is essentially a continuation of a previous paper entitled *Earthquakes associated with the 1933 eruption of Mauna Loa, Hawaii,*[2] although a sharp line cannot be drawn between the aftershocks associated with the 1933 eruption of Mauna Loa and the foreshocks of the 1934 eruption of Kilauea. However, because the eruptions of Mauna Loa and Kilauea were the only known eruptions in Hawaii in 1933 and 1934, respectively, the earthquakes for these years are described as being associated in 1933 with the Mauna Loa eruption and in 1934 with the Kilauea eruption.

The same seismograph stations (Table 1) were maintained in 1934 as in 1933 for as long a period as finances permitted.

TABLE 1.—SEISMOGRAPH STATIONS IN HAWAII IN 1934

Name	Symbol	Name	Symbol
Hawaiian Volcano Observatory	V	Hilo[a]	H
Uwekahuna	U	Kealakekua[a]	K
Halemaumau (Pit)	P	Waiku[b]	W

[a] Stations run by volunteers
[b] Station discontinued October 1934

These stations were maintained by the U. S. Geological Survey and the Hawaiian Volcano Research Association. The work done by the writer was undertaken as a cooperative project between the U. S. Geological Survey and the University of Hawaii.

The locations of the earthquakes shown in Table 2 and on Figures 1 and 2 were made by the graphical method of Isikawa,[3] using the S-P curves developed in previous studies of the Hawaiian volcanic earthquakes.[4] These previous studies indicate that the following

[1] Published by permission of the Director, U S Geological Survey. Received June 19, 1935.

[2] JONES, AUSTIN E. *Earthquakes associated with the 1933 eruption of Mauna Loa.* This JOURNAL 24: 413–418. 1934.

[3] BYERLY, PERRY. Bull. N. R. C. *Physics of the Earth, 6, Seismology,* p. 162.

[4] JONES, AUSTIN E. Hawaiian Travel Times Bull. S. S. A. 24: no. 1; *A Seismological Study of the Kilauea Eruption 1931–1932.* Univ. of Hawaii research paper no. 9.

TABLE 2.—EARTHQUAKES PRECEDING AND FOLLOWING THE 1934 ERUPTION OF KILAUEA

Map No	Date	No of Phases	Lat N ° ′	Long. W ° ′	Recording stations	Depth	Intensity[d]	Remarks
1	Jan 2	2?	19 50	155 27	VHW	5	v f	Felt in Honomu, Waikii, Kilauea
2	Jan. 6	1	19 30	155 36	P	?	v f.	Felt in Mokuaweoweo
3	Jan 7	2	19 23	155 16	VPU	5	v f	Not felt, in Kilauea
4	Jan 7	1	19 23	155 16	VPU	4	v f	Not felt, in Kilauea
5	Jan 9	3	19 09	155 41	VKHW	?	slight	Felt generally, phases confusing
6	Jan 13	1	19 10	155 10	VKHW	19	slight	Felt generally in Hawaii
7	Jan 16	1	19 23	155 17	VPU	0	tr	Not felt, near Kilauea
8	Jan 19	3	19 13	155 27	VHK	?	feeble	Not felt
8A	Jan 25	1	19 18	155 22	VPU	10	v f.	
9	Jan 30	3	19 30	155 33	VHKW	13	feeble	
10	Feb 1	3	19 23	155 40	VKHW	0	v f	
11	Feb 9	3	19 18	155 33	VHKW	10	slight	Felt generally, stronger at Kapapala
12	Feb. 19	2	10 26	155 14	VHK	5	slight	Located and felt near Kilauea crater
13	Feb 24	2	19 40	155 40	KHW	20	feeble	Felt in NE Hawaii
14	Mar 1	4	19 31	155 31	KHV	14–24	slight	Felt generally, may be shallower
15	Mar 10	2	19 32	154 48	VH	?	v.f	Not felt
16	Mar 10	2	19 20	155 10	VUH	8	v f	Not felt
17	Mar 11	2	19 24	155 03	VP	?	tr	Very doubtful location
18	Mar 13	2	19 26	155 14	VPU	?	v f.	Doubtful location
19	Mar 18	2	19 24	155 15	VPU	1	v f	
20	Mar 24	2	19 21	155 11	VP	?	v f	Located on a line,[c] at no 16
21	Mar 29	3	18 58	155 59	VKH	14	v f	On Mauna Loa SW rift
22	Mar 30	2	19 22	155 11	VP	?	v f.	
23	Apr 3	4	19 44	154 38	VH	?	v f	Probably shallow East of Hawaii
24	Apr 6	2	19 30	155 16	VUH	1	v f	
25	Apr 9	3	20 04	155 51	VKH	?	v f	Felt in Kohala
26	Apr 9	4	20 11	155 28	VKH?	?	feeble	Felt in Kohala
27	Apr 11	3	19 20	154 50	VH	?	v f	Not felt
28	Apr 12	1	19 24	155 16	VPU	2	v f	Not felt in Kilauea
29	Apr 13	3	19 37	155 37	VHK	0–5?	feeble	Not felt
30	Apr 14	5	19 37	154 47	VKH	?	slight	Felt in Hilo and Olaa
31	Apr 15	1	19 24	155 11	VPU	?	v f	Felt near Kilauea
31A	Apr 17	3	19 21	155 03	VH	?	v f	Not felt
32	Apr 24	2	19 14	155 46	VK	?	v f	Not felt
33	Apr 30	1	19 44	154 30	VH	?	tr	Probably deep
34	May 9	1	19 27	155 30	KHP	42	v f	
35	May 10	2	19 39	155 23	VHK	22	moderate	Felt generally, with alarm in Hakalau, slight damage in Hilo Felt on the island of Maui 180 km distant
36	May 10	3	19 38	155 24	VKH	44?	v f	Aftershock felt in Hakalau, may be shallower
37	May 10	3	19 18	155 20	VKH	18	feeble	Felt at Kilauea and in Hilo
38	May 13	3	19 29	155 29	VKH	9	slight	Felt, location agrees with angle from V
39	May 13	2	19 18	155 27	VKH	5	feeble	Felt; location agrees with V and K angles
40	May 16	1	19 10	155 30	VK	?	v f	Focus deep?
40A	May 22	1	19 24	155 16	VPU	0	v f	In Kilauea crater
41	May 30	3	19 47	156 10	VK	?	tr	
42	June 5	3	19 38	155 12	VKH	11	v.f	Larger record at Hilo anomolous (S–P)
43	June 15	3	19 31	155 23	VKH	?	v.f	
44	June 25	3	19 34	155 13	VKH	19	v f	
45	June 26	2	19 15	155 07	VKH	24	moderate	Felt generally
46	June 27	2	20 00	155 15	VH	?	v f	Felt in Honokaa
47	July 5	2	19 21	155 37	VHK	24	v f.	Tremor at W
48	July 5	1	19 33	155 23	VHK	3	v.f	
49	July 20	2	19 24	155 16	VKHPU	1	slight	Felt strongly near Pit
50	July 25	5	19 17	155 25	VHK	34	v f	Felt at Kapapala First location at no 64 may be better, 7 km deep
51	July 30	3	19 40	155 50	VK	?	v f	Not felt in Kona
52	July 30	2	19 21	155 12	VPU	7	v f.	At no 16
53	July 30	1	19 23	155 17	VPU	3	v f.	
54	July 31	1	19 25	155 15	VHPU	9	v f	
55	*Aug 7*	*3*	*19 32*	*155 31*	VKH	?	v f.	*Distance circles fail to intersect*
56	Aug 11	2	19 32	155 32	VKH	30	v f	Felt in Hilo
57	Aug 16	1	19 32	155 16	VKH	5	slight	Felt in Hilo and Honomu
58	Aug 25	1	19 25	155 16	VPU	2	v f	Kilauea crater
59	Aug. 28	2	19 25	155 16	VP	?	v f	Felt and located near or in Kilauea crater
60	Sept. 6	2	19 25	155 17	VPU	0	slight	Awakened residents near Kilauea crater
61	Sept. 6	1?	19 24	155 17	VPU	0	feeble	Outbreak of lava in Pit
62	Sept. 17	2	19 06	155 16	VHK	20	feeble	Felt in Hilo and Honomu
63	Sept. 22	2	19 15	155 20	VHK	11	feeble	Two of seven felt at Kapapala

TABLE 2. (*Continued*)

Map No.	Date	No of Phases	Lat N ° ′	Long W ° ′	Recording stations	Depth	Intensity[d]	Remarks
64	Sept. 23	1	19 15	155 27	VKH	24	v f	
65	Oct 3	2	19 19	155 27	VKH	31	v f	At no 39
65A	Oct. 12	1	20 10	155 30	V?K?H	120?	tr	
65B	Oct 12	—	20 00	155 30	no	?	tr ?	Felt in Honokaa
66	Oct. 13	2	19 23	155 28	VKH	60	moderate	Felt generally
67	Oct 18	2	19 31	155 39	VKH	58	feeble	Felt generally
68	Oct 18	1	19 31	155 39	VHK	?	v f	Aftershock at no 67
69	Oct 27	1	19 33	155 32	VKH	45	feeble	Felt near Kilauea
70	Nov 12	2	19 12	155 2?	VH	?	v.f	

[a] An earthquake recorded on two stations only can be located indefinitely on a line, unless directions are used. Distances from three stations may define a point.

[d] Increasing intensity on the Hawaiian volcanic scale, starting with the least and comparing with the Rossi-Forel scale in Roman numerals, is, tremor, I, very feeble, I, feeble, I; slight, II, moderate, III, and strong IV.

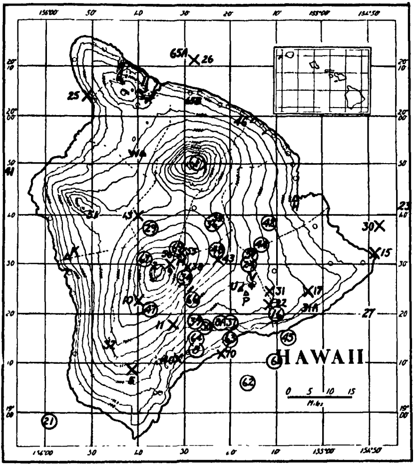


Fig 1 —Earthquake epicenters in Hawaii.

equations, although not perfect, for very near and high focus earthquakes are better.

$$S_1\text{–}P_1 \quad :: \quad t_1 \quad :: \quad 0.333\Delta$$
$$S_2\text{–}P_2 \quad :: \quad t_2 \quad :: \quad 0.125\text{–}0.245\Delta$$
$$S_3\text{–}P_3 \quad :: \quad t_3 \quad :. \quad 0.20\text{–}0.217\Delta$$

These curves supersede the t_s equation used in the 1933 study. The t^* and t_n curves are still considered applicable. Because these curves were derived from the study of earthquakes that probably occurred within eight kilometers of the surface, it is doubtful if they give more than approximate data when used for finding the deeper foci, although the figures obtained should be roughly proportional.

The preliminary seismographic results for 1934 were published in the monthly issues of the Volcano Letter.[5] Approximately 40,000 minutes of harmonic tremor were recorded as resulting from the eruption in Halemaumau, and 1,400 *spasmodic tremors*, or minutely recorded earthquakes, were recorded from unknown areas. Of the 168 stronger shocks recorded about 25 percent were felt, and about 40 percent of those recorded are located by this study.

The seismicity index, referred to in the Volcano Letter, is formed from earthquakes and tremors recorded at the Observatory. These phenomena are weighted in terms of the Rossi-Forel scale. This index is the basis of a continuous curve, that, in the opinion of the workers at the Observatory, is representative of the local volcanic activity. Study of the seismicity for 1933–1934 suggests that the activity of Mauna Loa was dying away for some months following the eruption. A peak seismic index, caused by a sequent swarm of earthquakes, was reached on February 5, 1934. It was followed by a lower peak on February 26. The lowest seismicity of the year was reached May 21–23. It was followed by a peak on June 10–17. This latter peak was possibly the unrecognized premonitory swarm preceding the Kilauea eruption of September 1934. There is some doubt of this, however, for another swarm of small earthquakes that centered less than 16 kilometers away from Kilauea crater, were recorded in July 1933. Premonitory swarms have been mentioned in the previous paper. Sequent swarms appear to follow the typical Hawaiian eruption after periods of from one to six months. A premonitory swarm came two months before the eruption of Kilauea in 1931–1932 and a sequent swarm came three months after.[6] Sequent swarms occurred seven

[5] Published by the Hawaiian Volcano Observatory, Hawaii National Park, T. H.
[6] JONES, A. E. *A Seismologic Study*. Op. cit.

weeks after the 1933 eruption and 11 weeks after the 1934 eruption.

The map (Fig. 1) shows the location of epicenters. Although there is considerable doubt as to the accuracy of the locations, it is thought that the true epicenters may lie inside the circles shown on the map. The larger scale map of Kilauea crater (Fig. 2) shows more accurately the locations near the crater.

Table 2 contains the map number, the date of occurrence, the number of P and S phases recognized in the Observatory record, the latitude and longitude, the initials of the stations used in locating the epicenter and focus, the apparent depth of focus in kilometers, the

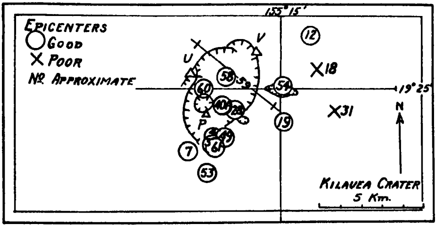


Fig 2.—Earthquake epicenters at Kilauea Crater.

intensity of the shock on the Hawaiian volcanic scale, and remarks mostly on macroseismic data.

Approximately one-seventh of the foci are under the sea, usually under the submarine slopes of the island. Less than a tenth fall under the quiescent volcanoes of Mauna Kea, Kohala and Hualalai. The remainder cluster primarily about Kilauea crater and secondarily about Mokuaweoweo crater on Mauna Loa.

The eruption in Mokuaweoweo crater apparently ended December 18, 1933. The previous paper gave the locations of nine earthquakes between that date and January 1, 1934.[7] The statement that "after the eruption the known seismic activity migrated away from the volcanic center" was violated three times in the three months immediately following the cessation of outflow (see epicenters 2, 9, and 14). During the next three months, earthquakes 29, 34, and 38

[7] JONES, AUSTIN E. Op. cit

occurred. Although they are not close to the crater of Mokuaweoweo, they, with 10, are definitely Mauna Loa shocks. It is believed that they are due to subsidence of the mountain, caused by withdrawal of the lava within.

The seismicity peak of June 10–17 was composed of a swarm of 102 spasmodic tremors. This seismicity peak later appeared to be premonitory in character, though it was not recognized as such at the time. Spasmodic tremors are very infrequently located, but by a process of elimination it appears that they often occur in the Kilauea area. The located earthquakes of about this time were occurring about 20 kilometers from Kilauea near the Mauna Loa northeast rift. More than half of the located shocks during July and August were near or in Kilauea crater. Earthquake number 49 was felt by several standing near Halemaumau Pit and in the vicinity of the southwest crater rim. It appeared less strong at the northeast end of the crater.

The eruption came as a surprise early on the morning of September 6. The premonitory swarm in June was not intense enough to attract much attention. A swarm that did attract attention occurred in July 1933 but it is doubtful if the eruption pended for 14 months; although in September 1934 the earthquake activity indicated that the lava was immediately below the earth's surface ready to break out. The fact that part of the lava spurted out of a fresh rift high up on the walls of the Pit would imply that the conduit had been well sealed.

Study of the tilt as measured by the seismographs at the Observatory and at Halemaumau Pit gave some qualifying facts. The observatory records also show that the tilt was to the northeast, or away from the crater, for some time prior to the outbreak. This is not significant for at that time of year the change in the annual tilt is usually to the northeast. It was noticed that the year's accumulated tilt, compared with the same period in 1933, was to the northeast.[8]

Study of the Halemaumau seismogram showed that there was considerable southwest tilt about 12 hours before the outbreak, that is, away from the crater at that point. Two and a half hours before the outbreak the first small shock was recorded. It was followed by several others, none of them being over two kilometers distant. They were accompanied by a stronger west tilt that soon had the E-W seismograph pen in its limiting position. At 2:21 A.M., 20 minutes before the outbreak of lava the slight earthquake, located at 60, awakened most of the people living on the rim of Kilauea crater,

[8] Volcano Letter, August, 1934.

A few more unlocated and very feeble shocks were recorded before the final shock occurred at 2:44 A.M. So far as known this last shock, located at 61, was coincident with the flowing of the lava. In less than a minute the earthquake coda had faded into harmonic tremor that continued to record for a month. The maximum ground amplitudes at the Halemaumau seismograph were approximately 80 to 100 microns during the first two hours whereas at the Observatory they were about 50 microns; the period remained at 0.6 second. The illustrations of the seismograms made during an eruption of Vesuvius[9] shows a harmonic tremor that is similar to that recorded during an eruption of Kilauea.

During the eruption the four located earthquakes were south and southwest of Kilauea crater and deeper than the average. After the eruption the located shocks were more scattered and even deeper. As after the Mauna Loa eruption, the known seismic activity was for a time at some distance from the volcanic center. Few earthquakes were recorded during November and December 1934. The peak of the sequent swarm did not occur until January 4, 1935.

CHEMISTRY.—*A new chloroarsenate of calcium.*[1] C. M. SMITH, Bureau of Entomology and Plant Quarantine.

Chloroarsenates of many of the metals are reported in the literature. Those mentioned in Volume IX of Mellor's *Comprehensive treatise on inorganic and theoretical chemistry* include two compounds of calcium, namely $Ca(CaCl)AsO_4$ and $Ca_4(CaCl)(AsO_4)_3$. The first has been reported as having been made only by fusion, and the latter both by fusion and by heating the reacting chemicals with water in sealed tubes.

When the author undertook a study of calcium arsenate several years ago, he considered the possibility of the formation of chloroarsenates of calcium in aqueous solutions at ordinary pressure in a manner similar to the formation of mimetite from dilead arsenate and soluble chlorides demonstrated by McDonnell and Smith (Amer. Jour. Sci. **42**: 139–145, Aug. 1916). In the effort to produce such compounds, dicalcium arsenate, $CaHAsO_4 \cdot H_2O$, was heated on the steam bath with concentrated solutions of calcium chloride. None of the experiments produced either of the compounds described in the literature, but from several of them there was obtained a well-crystallized compound with a composition corresponding to the

[9] SIGNORE, FRANCESCO. Bulletin Volcanologique 19–22: 48 1929.

[1] Received May 27, 1935.

formula $(CaCl)_2HAsO_4 \cdot 2H_2O$. The experiment which produced the best specimen of this material was performed as follows:

Fifty g of anhydrous $CaCl_2$ was dissolved in 50 cc H_2O, and 5 cc concentrated HCl added to destroy the carbonate and hydroxide which were present. Then dicalcium arsenate, $CaHAsO_4 \cdot H_2O$, was added to saturation and the mixture set on the steam bath. In the course of 11 days a crystalline precipitate formed. At the end of that time a large volume of alcohol (in which $CaCl_2$ is easily soluble) was added to prevent hydrolysis of the solid material and the latter was filtered on a Büchner funnel, washed with alcohol, and dried at 110° for one-half hour, at the end of which time the alcohol had been completely expelled.

Analysis of this product gave the following results:

	Theory for $(CaCl)_2HAsO_4 \cdot 2H_2O$ Percent	Found Percent
Ca	24.50	24.30
$HAsO_4$	42.79	42.54
Cl	21.69	21.55
H_2O of cryst.	11.02	11.61 by diff.
	100.00	100.00

Examination with the polarizing microscope showed an apparently uniform product consisting of well-formed crystals with parallel extinction, lying almost invariably perpendicular to the acute bisectrix. The optic angle is about 120° in air, and the negative character is well marked. The crystals are very probably orthorhombic. There appears to be no doubt that this is a definite chemical individual. The formula assigned to it is empirical, and was adopted merely as a means of relating the compound to the normal calcium arsenates.

BOTANY.—*Three new species of* Aphelandra *from Colombia.*[1] E. C. Leonard, National Museum. (Communicated by William R. Maxon.)

The new species described in this paper are based on material collected in the region of Mt. Chapón, Department of Boyacá, Colombia, by A. E. Lawrance. The type specimens of two are in the her-

[1] Published by permission of the Secretary of the Smithsonian Institution. Received June 11, 1935.

barium of the Royal Botanic Gardens, Kew; the other is in the U. S. National Herbarium.

Aphelandra lawranceae Leonard, sp. nov.

Herba perennis, suffruticosa; folia basi spicae subrosulatim conferta, anguste oblongo-elliptica, apice acuta, basin versus sensim angustata et in petiolum decurrentia, glabra, subtus purpurea, spicae terminales, simplices, sessiles; bracteae imbricatae, oblongo-lanceolatae, acuminatae vel acutae,

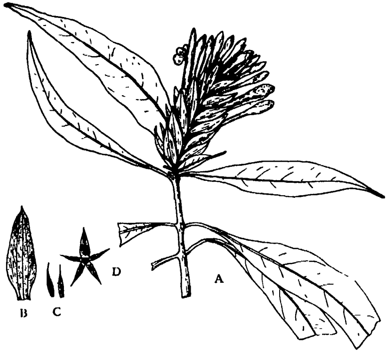


Fig. 1.—*Aphelandra lawranceae* Leonard, sp. nov A, plant, one-half nat size; B, flower bract, C, bractlets, D, calyx spread to show segments (B, C, D, nat. size)

integerrimae, puberulentae, ciliatae; bracteolae et calycis laciniae striatae, puberulentae; corolla coccinea, puberula, labio superiore integro, inferiore trilobo, lobis subaequalibus.

Suffrutescent, up to 12 cm. high; stems terete, glabrous, more or less verrucose; leaves opposite, the internodes 1.5 to 5 cm. long, or often 4 or 5 pairs crowded at the base of the spike, forming a rosette; leaf blades narrowly oblong-elliptic, up to 17 cm. long and 3 cm. wide, gradually narrowed at base and decurrent on the petiole, acuminate at apex, ending in a blunt tip, entire or undulate, both surfaces glabrous, the under surface often dark mauve; petioles up to 2 cm. long; spike terminal, up to 7 cm. long and 2 cm. in diameter, the rachis puberulent; bracts rather closely imbricate, erect-spreading, oblong-lanceolate, up to 2.5 cm. long and 9 mm. wide (narrowed to 5 mm. at base), abruptly acuminate to acute at apex, entire, puber-

ulent, ciliate; bractlets narrowly lanceolate, up to 9 mm. long and 1.5 mm. wide, 1-nerved, striate, puberulent, some of the hairs glandular; calyx segments subequal, about 9 mm. long, narrowly lanceolate, acuminate, the posterior one 3 mm. wide, minutely bidentate at apex, the anterior pair 1.7 mm. wide, the lateral pair 1.5 mm. wide, all striate, puberulent toward tip (glandular and eglandular hairs mixed); corolla up to 6.5 cm. long, brilliant red, finely pubescent, the tube gradually enlarged from 3 mm. at base to 5 mm. at throat, the upper lip entire, oblong, about 15 mm. long and 6 mm. wide, the lower 3-lobed, the lobes subequal or the lateral slightly shorter, up to 2 cm. long, the middle lobe obovate, up to 8 mm. wide, the lateral lobes oblong, up to 6 mm. wide; filaments about 3.5 cm. long, glabrous or minutely pubescent toward base; staminode slender, about 13 mm. long, pubescent at tip; style puberulent; ovary glabrous below, pilosulous above.

Type in the U. S. National Herbarium, no. 1,482,539, collected in the forest region of Mt. Chapón, Department of Boyacá, Colombia, alt. about 1650 meters, June 17, 1932, by A. E. Lawrance. *Lawrance* 243 and 252, from the same locality, are also of this species.

This beautiful and rare species is conspicuous because of its brilliant red flowers and purple leaf blades. The spike, bracts, and corollas resemble those of *Encephalosphaera vitellina* Lindau, but that species is described as having the leaves ovate, rather than narrowly oblong-elliptic, and the pollen grains are globose and marked by clefts into six nearly equal spherical squares, whereas those of *A. lawranceae* are of the elongate "spaltenpollen" type, i.e., marked by clefts extending from one end of the grain to the other. Named in honor of Mrs. E. A. Lawrance, wife of the collector.

Aphelandra alexandri Leonard, sp. nov.

Herba perennis, suffruticosa, glabra; folia elliptica, apice acuminata, basi sensim in petiolum angustata; spicae terminales, simplices, sessiles; bracteae imbricatae, oblongo-ellipticae, acutae, integerrimae; bracteolae lineares; calycis laciniae lanceolatae subaequales; corolla extus scarlatina, intus flava, labio superiore elliptico, acuto, inferiore trilobo, lobis subaequalibus.

Suffrutescent, glabrous, up to 1 meter high; leaf blades elliptic, up to 15 cm. long and 5 cm. wide, narrowed at base and decurrent on the petiole, acuminate, ending in a blunt point, entire or undulate, green, the costa and lateral veins (9 or 10 on each side) rather prominent; petioles up to 3 cm. long, winged; spikes terminal, sessile, up to 10 cm. long and 2 cm. in diameter, the bracts rather closely imbricate, erect or erect-spreading, oblong-elliptic, up to 18 mm. long and 3 mm. wide at base and 1 cm. wide at middle, acute at apex, subchartaceous, veiny; bractlets linear-subulate, 1 mm. wide at base, striate; calyx segments lanceolate, subequal, 8 or 9 mm. long, bearing at base triangular calluses (these conspicuous on the outside), the posterior segment oblong, 2.5 mm. wide, 2- or 3-toothed at tip, the anterior pair (1.5 mm. wide) and the lateral pair (1 mm. wide) narrowly lance-attenuate; corolla about 6 cm. long, brilliant red without, yellow within, glabrous except the lips, these minutely pruinose within; tube gradually enlarged from 4 mm. in diameter at base to 6 mm. at mouth, the upper lip elliptic, about 2 cm. long and 8 mm. wide, acute, the lower lip 3-lobed, the lobes subequal, oblong-obovate, about 2 cm. long, 7 to 8.5 mm. wide near middle, acute or acutish at apex; staminode not evident in flower examined;

filaments and style glabrous; pollen grains elongate, muricate, of the "spaltenpollen" type.

Type in the Kew Herbarium, collected in the region of Mt. Chapón, Department of Boyacá, Colombia, Feb. 4, 1933, by A. E. Lawrance (no. 601).

Related to *A. lawranceae*, which it resembles closely in many respects. The bracts and corolla are strictly glabrous, however, whereas in *A. lawranceae* the bracts are densely puberulent and the corolla is pubescent. Furthermore the flowers of this species are yellow within, but those of *A. lawranceae* are red throughout.

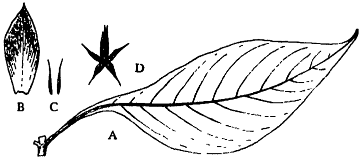


Fig. 2.—*Aphelandra alexandri* Leonard, sp. nov. A, leaf, one-half nat. size, B, flower bract; C, bractlets; D, calyx spread to show segments (B, C, D, nat. size)

Aphelandra parviflora Leonard, sp. nov.

Herba; caulis simplex, basi procumbens, nodis infimis radicans, adpresso-pilosus; folia pauca, oblonga, apice acuta vel obtusa, in petiolum decurrenti-angustata, subglabra, costa et nervis lateralibus strigosis; spica gracilis, pedunculis elongatis, fere nudis, strigosis; bracteae erecto-patentes, ellipticae, grosse spinuloso-serratae, parum strigosae; bracteolae subulatae, subhyalinae; calycis laciniae oblongo-acuminatae, subaequales, glabrae (marginibus exceptis), striatae; corolla parva, flava, minute pilosa, labio superiore bilobo, inferiore trilobo, lobis orbiculatis.

Herbaceous, the stem 10 cm. high or more, ascending, rooting at the lowermost nodes, strigose; leaves usually several, the blades oblong, up to 25 cm. long and 18 cm. wide, elliptic, obtuse or obtusish at apex, cuneate at base and decurrent on the petioles, entire or undulate, purple beneath, sparingly strigillose, glabrescent except for costa and lateral nerves (15 to 18 pairs), these strigose; petioles slender, up to 6 cm. long, strigose; spikes slender, up to 13 cm. long, about 1 cm. in diameter, the peduncles up to 12 cm. long, strigose, bearing a pair of bractlike leaves about 2 cm. below the base of the spike; bracts rather loosely imbricate, erect-spreading, elliptic, 1 cm. long, 3 to 4 mm. wide, acuminate, ending in an obtuse tip, firm, veiny, sparingly strigose, with several erect-spreading narrow teeth up to 1.5 mm. long on each side; bractlets lance-subulate, 3.5 mm. long, 1 mm. wide at base, thin, subhyaline, nerved; calyx segments narrowly oblong, acuminate, subequal, 5 to 6 mm. long, the posterior one 2 mm. wide, the anterior pair 1.5 mm. wide, and the lateral pair 1 mm. wide, subhyaline, striate-nerved, minutely

glandular-ciliolate; corolla yellow, 1 to 1.5 cm. long, obliquely hypocrateriform, minutely and sparingly pubescent, the tube 1 mm. broad at base, about 4 mm. broad at mouth; limb about 8 mm. broad, the lips equal, the upper one 2-lobed, 5.5 mm. broad, the lower 3-lobed, the lobes orbicular, 4.5 mm. in diameter; stamens included.

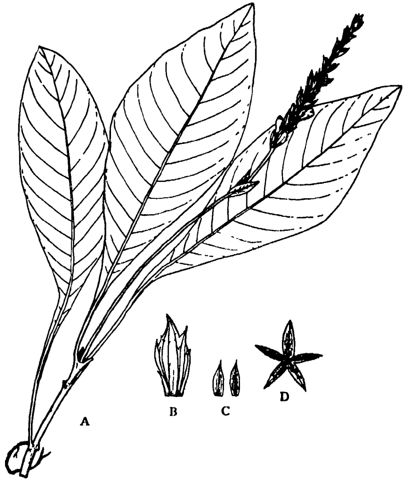


Fig. 3—*Aphelandra parviflora* Leonard, sp nov. A, plant, one-half nat. size, B, flower bract, C, bractlets; D, calyx spread to show segments (B, C, D, twice nat. size.)

Type in the Kew Herbarium, collected in the region of Mt. Chapón, Department of Boyacá, Colombia, June 10, 1932, by A. E. Lawrance (no. 201). Represented also by *Lawrance* 291, from the same locality.

Well marked by its purple leaves and loose, slender pedunculate spikes of small flowers.

PALEOBOTANY.—*Some fossil conifers from Maryland and North Dakota.*[1] Roland W. Brown, U.S. Geological Survey.

Fossil cones and other remains, resembling or suggesting those of living coniferous species, are not rare in American Cretaceous deposits. The fact that many of these cones are found detached, although often associated in the same strata with foliage and fossil wood, is a circumstance that has resulted, perhaps unavoidably, in the description of numerous species, many of which, unfortunately, are based upon very fragmentary types whose characters, especially when figured, are so misleading that identification of new specimens by comparison with them, is difficult for experienced and inexperienced students alike. It is considered appropriate, therefore, in looking toward a clarification of this condition, to describe and figure such new and better material as may be discovered.

MARYLAND FOSSIL CONIFERS

The writer's interest in an unreported locality for Lower Cretaceous fossil plants in Maryland was enlisted early this year (1935) by James H. Benn, of the U.S. National Museum, and two young Washington collectors, Floyd A. Rapp and Douglas Graham, who found in deposits there a large amount of fossil wood and several well-preserved cones. This locality includes about 1500 feet along the bank of the Northwest Branch of the Anacostia River, beginning at the new bridge on Queen's Chapel Road, three-fourths mile beyond the District of Columbia line, and running northwestward upstream. The general geologic section and situation of this exposure are as sketched in Figure 13. The Northwest Branch, in that part of its course, has cut a channel 6 to 10 feet below the floodplain surface through comparatively young alluvium composed of sands, sandy clays, and gravels, into slightly southeastwardly dipping Lower Cretaceous sediments consisting of bluish sandy clays, crossbedded sands, and infrequent lenses of fragmental material cemented by iron oxide. That the latter are Lower Cretaceous strata is clearly demonstrated from the fact that a little more than a mile west of this locality the igneous and metamorphic basement complex emerges, and since its eroded surface, upon which the Lower Cretaceous deposits rest, slopes seaward at the rate of 75 to 100 feet per mile, it follows that the strata outcropping at the locality on Northwest Branch are about 125 feet above that unconformity and belong to the Lower Cretaceous

[1] Published by permission of the Director, U.S. Geological Survey. Received July 24, 1935.

Potomac group, for the total thickness of that group at nearby points in the District of Columbia and Maryland reaches approximately 600 feet.

At the bottom of the sketch the waters of the Northwest Branch are shown washing the Cretaceous outcrop and its embedded fossil wood. These prostrate logs, some measuring nearly 6 feet in diameter, are much flattened and are jumbled or matted together in a manner suggesting driftwood. They are now lignite, jet-black in color, with occasional impregnations and fillings of marcasite. The wood, in many instances, shows well-preserved cellular structure that indi-

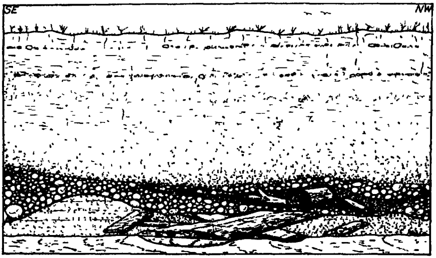


Fig 13.—Sketch of geologic section, 8 feet deep, along Northwest Branch of Anacostia River, Md The irregular line A--B marks the great unconformity between the Lower Cretaceous and young alluvial deposits.

cates its coniferous relationship alluded to in the name, *Cupressinoxylon wardi*, given it by F. H. Knowlton in 1889. Only rarely may cones, such as those to be described below, be found among these wood remains.

It is conjectured that if this Cretaceous deposit could be uncovered over a large area thousands of logs might be revealed, simulating in some respects but on a smaller scale, a sight like that in the Petrified Forest of Arizona. However, such an exposure of this lignite would not persist intact for many days because on drying the wood checks and disintegrates rapidly. To preserve cones and wood of this kind it is necessary to remove the absorbed water from them but they must be prevented from drying in air. This may be accomplished by dehy-

drating the specimens for several hours in 95 per cent alcohol and then shellacking them with a thin solution of celloidin in acetone or some similar preparation.

The irregular line A—B in Figure 13 represents the eroded, channeled surface of the Cretaceous strata upon which rest 6 feet, more or less, of younger alluvium beginning at the bottom with a foot or more of coarse gravel and sand and grading upward through two sequences of sand, sandy clay and silt, to top soil. In the gravel at the base is a lens of sand and clay from which by sieving with a fine screen there have been recovered a number of decalcified fresh-water mussels (*Elliptio complanatus*), insect fragments including four beetles (*Calosoma scrutator*, *Chlaenius impunctifrons*, *Dicaelus* sp., *Euphoria fulgida*), unflattened, little-altered logs and branches of white pine (*Pinus strobus*), northern hemlock (*Tsuga canadensis*), and white oak (*Quercus alba*), and 35 species of fruits and seeds (*Pinus strobus*, *Tsuga canadensis*, *Sparganium androcladum*, *Potamogeton nuttallii*, *Carex* sp., *Quercus alba*, *Q. rubra*, *Q. phellos*, *Corylus americana*, *Carpinus caroliniana*, *Hicoria glabra*, *H. ovata*, *Juglans cinerea*, *Myrica carolinensis*, *Polygonum* sp., *P. hydropiperoides*, *Liriodendron tulipifera*, *Tilia americana*, *Staphylea trifolia*, *Platanus occidentalis*, *Prunus serotina*, *Rubus* sp., *Phytolacca decandra*, *Claytonia virginica*, *Sassafras variifolium*, *Impatiens biflora*, *Rhus glabra*, *Vitis* sp., *Sambucus canadensis*, *Viburnum acerifolium*, *V. prunifolium*, *Nyssa sylvatica*, *Cornus amomum*, *C. florida*, *C. paniculata*). Of these 35 species, probably all but two, northern hemlock and shagbark hickory, may be found living in the basin of the Northwest Branch today. The nearest native hemlocks are in the vicinity of Occoquan and Great Falls, Virginia, and these appear to be relict stands abandoned when the species kept pace northward with the receding cool climatic conditions accompanying the dissipation of the last Pleistocene ice sheet. Although the writer has seen no shagbark hickories along the Northwest Branch it is possible there may be a few scattered trees in the upper reaches of the basin.

This collection of relatively recent material will remind those interested in the younger deposits of the District of Columbia and vicinity of the remains taken from the excavations for the Mayflower Hotel[2] and Government Printing Office.[3] The significant species in those collections was the bald cypress (*Taxodium distichum*) which is not

[2] This Journal 14: 1-41 1924.

[3] Berry, E. W *New occurrences of Pleistocene plants in the District of Columbia.* This Journal 23: 1-25. 1933.

present in the collection from the Northwest Branch. Conversely, hemlock and shagbark hickory are absent from those collections; but the Printing Office collection is nevertheless more closely comparable to that from the Northwest Branch than is that from the Mayflower site, which is regarded as representing a flora adapted to slightly warmer, or in some way, more congenial, climatic conditions than those obtaining at present. The altitude of the deposit in the Mayflower Hotel excavation is between 40 and 60 feet; that at the Printing Office, 20 feet; and that on the Northwest Branch, between 25 and 30 feet above sea level. Because of these respective elevations the deposit at the Mayflower site is considered as belonging to the Wicomico terrace stage of the mid-Pleistocene, and the deposit at the Printing Office to the Pamlico terrace stage of the late Pleistocene. On this basis the deposits on the Northwest Branch, if they are terrace sediments, which is not proved, should be assigned to the Pamlico or to the transition between Talbot and Pamlico. The evidence from the organic remains is not strictly conclusive. The state of preservation of the remains is about the same at all these localities. The mussels and beetles are found in the Anacostia River region today; and so far as the plants are concerned, the only positive statement that can be made is that the deposits antedate the disappearance of northern hemlock from that basin.

It is worth noting that both the Cretaceous and younger driftwood were very likely accumulated in the same manner, but at an interval of about 125,000,000 years, represented in the unconformity A—B. During the passage of that unimaginably long period of time the flowering plants (angiosperms) evolved from their primitive Cretaceous ancestors and gradually displaced in dominance the ferns, cycads, and conifers that clothed the land surface of this part of the country when these Lower Cretaceous sediments were deposited.

The species of cones from the Cretaceous strata are as follows:

Abietites macrocarpus Fontaine Fig. 12

Abietites macrocarpus Fontaine. U.S Geol. Survey, Mon. **15:** 262, pl. 132, fig 7 1890.—Berry, E. W. *Lower Cretaceous.* Md. Geol. Survey, p. 405, pl. 67, figs. 1–4. 1911.

Cone, 14.5 cm. long, 2 2 cm. in diameter, with numerous, imbricated, thin, striated, persistent scales, having rounded or emarginate upper margins. Jet-black and lignified.

The type of this species described by Fontaine from Lower Cretaceous strata at Dutch Gap Canal on the James River, Virginia, is a fragmentary longitudinal section of a narrow, elongated cone with broken scales. The present specimen exhibits the characters of the type, so far as those features

can be determined, but being complete and well-preserved, is figured here as a more readily recognizable typical example of the species. That the species is a primitive *Abies*, as the name implies, may well be doubted, because, if judged by the nature of cones from living species of *Abies*, the scales should not be persistent long after maturity. *Piceites* might be a better reference than *Abietites*. Unfortunately no foliage was found with this cone, nor were seeds present between the scales. Evidently the cone had matured, shed its seeds, and fallen from the tree into the water that carried it to the site of entombment and lignification. Confusion of this species with *Pinus*, especially the white pine (*Pinus strobus*), whose long, narrow cones resemble the fossil, is unnecessary because the cone scales of *P. strobus* are distinctly acute and are tipped with round, blunt, resinous scars or points.

Figured specimen in the U.S. National Museum.

Cedrites primevus Brown, n. gen. and n. sp. Fig. 11

Cone, 10.5 cm. long, 4 cm. in diameter, narrowly elliptic in shape, with truncated apex. Scales relatively few, large, imbricated, broadly rounded, coarsely and sparsely striated, apparently persistent, with entire margins.

The figure reproduced here is that of a plaster cast made from the fossil which is a hollow mold or impression left in the rock matrix by the original cone, no remains of which were recovered with the impression. Choice of *Cedrites* as a name for this species should only be regarded as suggestive rather than as indicative of its botanic relationship. This species is three times larger and has fewer scales than that called *Cedrus leei* (Fontaine) Berry,[4] from Lower Cretaceous strata at Baltimore, Maryland.

Type in the U S National Museum.

Piceites cretaceus Brown, n. sp. Fig. 8

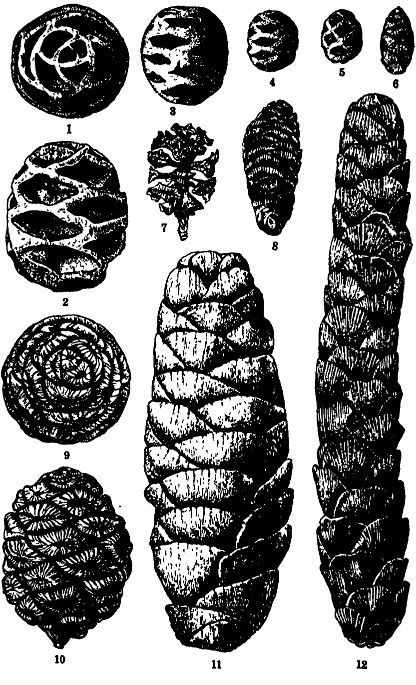
Cones, 3.5 cm long, 1.5 cm. in diameter, elliptic in shape, with blunt apex and cuneate base. Scales numerous, imbricated, rounded, finely striated, persistent, with entire margins. Jet-black and lignified.

Five specimens of this species are now in the National Museum collections. The fact that they are of uniform size appears to indicate that they represent a well-defined species different from any other so far described from Lower Cretaceous strata. The reference of the species to *Piceites* is based principally upon the rather striking resemblance of these cones to those of some species of *Picea*, particularly the white spruce (*P. canadensis*) of the northern United States The fossil species called *Pityites* (*Pinites*) *solmsi* Seward[5] from the Lower Cretaceous of England, is not unlike this species It seems reasonable to expect that a primitive predecessor of *Picea* should have been present in these early Cretaceous floras.

Type in the U.S. National Museum

The flora of the Lower Cretaceous of Maryland, the District of Columbia, and Virginia, is fully reviewed by Berry[6] who lists 144 species. These consist of ferns, clubmosses, horsetails, cycads, a ginkgo, conifers, and primitive angiosperms. The conifers number 29

[4] Berry, E. W. *Lower Cretaceous*. Md. Geol Survey, p 411, pl 77, figs. 4, 4a. 1911.
[5] Seward, A. C. *Fossil plants* 4· 373, text figs. 772, 773. 1919.
[6] Berry, E. W. *Lower Cretaceous*. Md. Geol Survey. 1911.



For explanation of Figs. 1–12, see bottom of opposite page.

species and are distributed among the genera *Nageiopsis*, *Cephalotaxopsis*, *Brachyphyllum*, *Araucarites*, *Abietites*, *Pinus*, *Cupressinoxylon*, *Frenelopsis*, *Sphenolepis*, *Laricopsis*, *Arthrotaxopsis*, *Widdringtonites*, *Cedrus*, and *Sequoia*. It is almost needless to say that, although most of these genera may be recognized readily, little is actually known about their exact botanic relationships. The disposition of the three cones discussed above must be regarded as tentative until cones and foliage are found in organic connection when a realignment may be necessary.

NORTH DAKOTA FOSSIL CONIFERS

A short distance beyond the bridge over the Cannonball River thirty miles south of Mandan, North Dakota, another highway branches off eastward toward Solen and the mouth of the Cannonball on the Missouri River. In secs. 31 and 32, T. 134 N., R. 81 W., on both sides of that highway, badlands appear in the somber-colored strata of the lower part of the Lance formation, immediately above the Fox Hills sandstone and beneath the Cannonball marine member of the Lance. The weathering of ferruginous lenses in these somber beds isolates the well-preserved mud casts of *Sequoia* cones (Figs. 1, 2). A similar occurrence in the same beds is located along the Cannonball River in sec. 36, T. 131 N., R. 86 W., where the cones are normally somewhat smaller in size. At both localities the writer and Kiguma J. Murata, of the United States Geological Survey, in 1931, found detached, fragmentary leaves and twigs of *Sequoia*.

Sequoia dakotensis Brown, n. sp. Figs. 1–4

Cones, 1.5–4 cm. long, 1.2–3 cm. in diameter, with about 30 scales, arranged in two sets of spiral rows, the steep-angled set in 5 rows, and the flat-angled set in 3 rows The faces of the scales present sections that are long and narrow, roughly diamond-shaped, but occasionally with one or two additional angles. Peduncle of the scales abruptly narrowed to the point of attachment at the axis of the cone. Surface of the scales smooth, or sometimes slightly wrinkled.

These cones are ferruginous mud casts, the solid portion of which represents the spaces, and the cavities the woody substance of original cones like those of the redwood (*Sequoia sempervirens*), Figure 7, or the big tree (*S.*

Figs. 1–4 —*Sequoia dakotensis* from the Eocene (?) of N. Dak. Fig. 1 is a top view of Fig. 2. Fig 5.—*Sequoia ambigua* from the Lower Cretaceous, Muirkirk, Md. Fig. 6.—*Tsuga canadensis* from alluvial deposits on Northwest Branch of Anacostia River, Md Fig. 7.—*Sequoia sempervirens*, living redwood, Calif. Fig. 8.—*Piceites cretaceus* from the Lower Cretaceous on Northwest Branch, Md. Figs. 9, 10.—*Sequoia gigantea*, living big tree, Calif. Fig. 11.—*Cedrites primevus* from the Lower Cretaceous on Northwest Branch, Md. Fig. 12.—*Abietites macrocarpus* from the Lower Cretaceous on Northwest Branch, Md. All figures natural size. Drawings by Miss Frances Wieser.

gigantea), Figures 9 and 10. Falling from a tree into water, the original cones became water-logged, sank to the bottom and were covered with mud that also filled the spaces between the scales. The dissolution of the wood helped to impregnate and harden the mud with iron oxide; but the spaces occupied by the slowly disintegrating woody scales did not have an opportunity to be filled with soft mud because the mud surrounding the cone had also hardened in the meantime; hence, in the resulting fossil casts the original woody parts are represented by cavities.

Some 50 species of *Sequoia* have been described from American strata ranging in age from Lower Cretaceous to Pleistocene. Many of these are designated merely as *Sequoia* sp., the rest by binomials. In few instances have cones and foliage been found in organic connection, so that it is most likely that more species have been described than the remains justify, although it is not improbable that 50 or more species or varieties of *Sequoia* may have been in existence during the long and widespread history of that genus. In describing the present cones as a new species the writer hopes that he is not adding to the confusion associated with the identification of fossil sequoias, many of which are based upon foliage which is known to be extremely variable and therefore not reliably diagnostic. A few species are based upon fossil wood.

Comparison of these cones with other well-preserved fossil *Sequoia* cones and with those of the living species, reveals significant differences. The scales of these cones number about 30 and are conspicuously longer than broad when viewed in face section. The normal number of scales in *S. sempervirens* varies from 14 to 26, in *S. gigantea* from 35 to 40. The fossil cones therefore belong to neither of the two living species. The fossil species, regarded as the most nearly equivalent to if not identical with the living redwood, is the Tertiary species, *S. langsdorfii*, but, having normally a less number of scales than the cones under discussion, it must be considered a different species, although Knowlton gives it a range that extends into the area and the horizon from which these cones were recovered, an extension of range and identification that apparently does not seem to be justified by the evidence. Another fossil cone given the same backward range as *S. langsdorfii* is *S. nordenskiöldi*. Since the cone type of this species described by Heer[7] is a longitudinal section only, and since there was no other basis, except figured foliage, for identifying the American material with Heer's Spitzbergen specimens there seems to be ground for questioning and perhaps rejecting this identification also. The cones of both these species taken from Cretaceous

[7] HEER, OSWALD. *Flora fossilis arctica* 2(abt. 2) 36, pl. 4, fig. 4a. 1870.

strata in North Dakota, although not identifiable with the types of those species, are, however, the same as the cones now called *S. dakotensis*.

An unattached cone similar in size and scale arrangement to *S. dakotensis* is that described by Knowlton as *Sequoia* sp.?[8] from Upper Cretaceous beds 10 miles northwest of Wild Horse Lake, Alberta, Canada. Found in the same Judith River strata on Willow Creek, 12 miles north of Musselshell post office, Montana, is much material, but no cones, of a *Sequoia* that Knowlton confidently referred to that ubiquitous Cretaceous species, *S. reichenbachi*. He intimated that the cone suggests some of the latter species figured by Heer from Greenland.[9] However, Heer's Figure 4 shows the face of the cone scales to be more broadly rhomboidal than those of Knowlton's cone. Similarly, Berry's cone[10] of this species, although smaller than Heer's, has the same broadly rhomboidal scale faces, agrees with Heer's type, but differs from Knowlton's. It appears therefore that the North Dakota and Alberta cones cannot be referred with assurance to *S. reichenbachi*. For the same reason, namely, the more broadly rhomboidal shape of the scale faces, that small-coned species, *S. ambigua* (Fig. 5), originally described by Heer from Greenland and reported by Fontaine[11] from Lower Cretaceous beds at Dutch Gap Canal, Virginia, and Muirkirk, Maryland, is a species different from *S. dakotensis*. Cones, similarly preserved and indistinguishable from *S. dakotensis*, were collected in 1907 by Barnum Brown from the Hell Creek member of the Lance formation in the valley of Big Dry Creek, 28 miles south of Lismas and 35 miles northwest of Circle, Montana, and were identified as *S. heeri* by Arthur Hollick. This, however, is clearly a misidentification, for Lesquereux's type of *S. heeri*[12] from Sage Creek, near Medicine Lodge, Montana, is a small, crumpled cone having less than 20 scales, and is, in fact, an example of *S. langsdorfii*, similar to the smaller cones of that species from the lower part (Bridge Creek shale of authors) of the John Day formation in Oregon, and also mistakenly identified as *S. heeri* by J. S. Newberry and F. H. Knowlton.

[8] STANTON, T. W., and HATCHER, J. B. *Geology and paleontology of the Judith River beds, with a chapter on the fossil plants* by F. H. Knowlton. U.S. Geol Survey, Bull. 257: 131, pl. 14, fig. 2. 1905.

[9] HEER, OSWALD. *Flora fossilis arctica* 3(abt 2) 77, pl 20, figs. 1-8. 1875.

[10] BERRY, E W *The upper Cretaceous and Eocene floras of South Carolina and Georgia*. U.S. Geol. Survey, Prof Paper 84: 23, pl 4, fig. 1. 1914

[11] FONTAINE, W. F. *The Potomac or younger Mesozoic flora*. U S. Geol. Survey, Mon. 15: 245, pl. 120, fig. 6. 1889.—Ibid, Mon. 48: 555, pl 110, fig 13 1905.

[12] LESQUEREUX, LEO. *The Tertiary flora*. U.S. Geol. Survey Terr Rept 7: 77, pl. 7, fig. 13. 1878.

The strata in which the cones of *S. dakotensis* were found belong to a group whose geologic age is in dispute, the United States Geological Survey designation being Eocene (?). Some students assign the beds to the Upper Cretaceous, others regard them as early Eocene. Similarly the age of the somewhat younger Fort Union formation has also been questioned. In the latter, at several localities in North Dakota, Montana, and Wyoming, the writer has found *Sequoia* cones that greatly resemble *S. dakotensis*, except that apparently the average number of scales is about 28, a reduction from *S. dakotensis* and an approach toward the *S. langsdorfii* and *S. sempervirens* types. Whether these considerations concerning *S. dakotensis* can be made a part of the basis for the geologic dating of these disputed beds remains to be tested by further evidence.

Types and figured specimens in the U. S. National Museum.

ORNITHOLOGY.—*A new race of the crested eagle-hawk,* Spizaetus ornatus.[1] HERBERT FRIEDMANN, U. S. National Museum.

On examining a long series of *Spizaetus ornatus*, representing the combined material of the Museum of Comparative Zoölogy, the Academy of Natural Sciences of Philadelphia, the Carnegie Museum, the Field Museum, California Institute of Technology, United States Biological Survey, and the United States National Museum, it became evident that there were two races involved, one from the Guianas, Brazil, and Venezuela, to Paraguay, northeastern Argentina, and Bolivia; and one from Mexico and Central America, south to Colombia and Ecuador, and, possibly, to Peru. When sending me the Carnegie Museum series, Mr. Todd wrote me that he had long suspected the existence of two races, a Central American and a South American. When I found that there were indeed two races although their ranges were not quite as Todd's brief note suggested, I wrote him suggesting that he describe the northern form. This he declined to do as I had all the material assembled before me. The least I can do in return for his courtesy is to use one of his specimens as the type of the new race.

Inasmuch as the type locality of *ornatus* is Cayenne, it follows that this name must be applied to the birds of the Guianas, Brazil, etc. Although several synonyms are extant for the nominate race, no name seems to be applicable to the Central American-western South American form. I therefore propose the name

[1] Published by permission of the Secretary of the Smithsonian Institution. Received June 29, 1935.

Spizaetus ornatus vicarius subsp. nov.

Type: Carnegie Museum number 24881, adult female, collected by Morton E. Peck, in the pine ridge country near Manatol Lagoon, British Honduras, July 5, 1905.

Subspecific characters: Adult similar to that of the nominate race, but with the sides of the face, neck, and throat duller, snuff brown to mikado brown (instead of cinnamon rufous to hazel as in typical *ornatus*); the abdomen more heavily streaked with black transverse spots; and with the black malar stripe from the angle of the bill, separating the brown cheeks and auriculars from the white chin and mid-throat, generally, but not invariably, broader: young similar to that of the nominate race, but with the crown generally more heavily washed with tawny cinnamon and with numerous, small, dark fuscous streaks (crown almost or entirely without dark fuscous streaks in young of the typical form).

Range: As indicated above—southern Mexico, Guatemala, Honduras, British Honduras, Nicaragua, Costa Rica, Panama, Colombia, and Ecuador. I have seen no Peruvian specimens and cannot say whether or not birds from that country are of this form. The species has been recorded from Chyavetas, Peru. I should expect from the fact that the Ecuadorian bird seen (from Paramba in northern Ecuador) is *vicarius* and that Bolivian examples seen (from Rio Surutu and Rio Yapacani) are *ornatus*, northern Peruvian birds would be closer to *vicarius* and southern and especially southwestern ones to *ornatus*.

I have seen no birds from Trinidad and assume that they are *ornatus* like those from Venezuela. However, the only Tobago bird seen, a young one, is as similar to *vicarius* as to *ornatus*. It may be, however, that the juvenal plumage characters of the two races are not valid, in which case there would be no reason for considering this bird *vicarius*.

Material examined: S. o. ornatus: 8 specimens from British Guiana, Brazil, Venezuela, Paraguay, Bolivia, and one from Tobago that may be *vicarius*.

S. o. vicarius. 25 specimens from Mexico, Guatemala, Honduras, British Honduras, Nicaragua, Costa Rica, Panama, Colombia, and Ecuador.

I am greatly indebted to Mr. Peters, Dr. Stone, Mr. Todd, Mr. Boulton, Mr. van Rossem, and Mr. Wheeler for the loan of material used in this study.

ZOOLOGY.—*Chinese spiders of the family* Lycosidae.[1] IRVING FOX. (Communicated by PAUL BARTSCH.)

Through the kindness of the United States National Museum I was granted the opportunity of studying a collection of spiders made by D. C. Graham in Szechwan Province, China, during the years 1923 to 1930. I wish to express my appreciation to the authorities of the Museum for their helpfulness while this study was in progress, and especially to E. A. Chapin, curator of the Division of Insects. All the species described or discussed in this paper are in the collection of the United States National Museum.

[1] Received June 27, 1935.

Arctosa gertschi, n. sp.

Male: Total length, 10.8 mm. Carapace, 6.23 mm. long, 4.05 mm. wide. Carapace dark brown in the alcoholic specimen, with indications of a lighter median band. Sides brown, with marginal lines of white hairs. Sternum, labium, endites, and coxae black. Legs reddish brown without annulations. The shrivelled abdomen is black.

First row of eyes narrower than the second (33/37), slightly procurved, the medians larger, closer to each other than to the laterals. Eyes of the second row their diameter apart. Third row wider than the second (45/37), and much narrower than the carapace at that point. Quadrangle of posterior eyes wider than long (45/34). Clypeus equal in height to five-sixths the diameter of the anterior median eyes. Chelicerae with two teeth on the lower margin, and three on the upper. Legs stout, the tibiae with 2-2-2-spines below, the last pair apical, the posterior tibiae with basal and submedian spines above. Tibia and patella I, 6.23 mm long. Tibia and patella IV, 7.02 mm. long. Male palpal organ as figured.

TYPE LOCALITY.—China: male holotype from Chaotung, Yunnan Province, 1925. Type: U. S. N. M. Cat. No. 1137.

Although this spider differs markedly from the generality of the species of *Arctosa* in the spinal armature of the anterior and posterior tibiae, the structure of the palpal organ is characteristic of that genus resembling in certain respects that of the male palpus of *Arctosa cinerea* (Fab), the genotype.

Lycosa wulsini, n. sp.

Female: Total length, 17.50 mm. Carapace, 9.30 mm. long, 7.13 mm. wide. Abdomen, 8.22 mm. long, 6.14 mm. wide. Carapace brown, with a median longitudinal light band which is wider than the posterior row of eyes anteriorly, but which narrows abruptly before the dorsal groove, and continues backward as a line about one-third the width of the anterior portion. Sides of the carapace dark brown with distinct broad, whitish, submarginal lateral stripes limited by narrower brown bands below them. Marginal lines of white hairs at the edges of the sides. Sternum, labium and endites black. Legs brown shaded with black; coxae black with lighter portions at the bases, femora with indistinct longitudinal black lines above. Abdomen brown above; at the base a solid black mark extending a little more than half the length of the abdomen. At the posterior portion of this mark, and below it are scattered numerous black dots. Venter of the abdomen with a solid black spot which would include the entire venter were it not outlined on all sides by an orange band.

First row of eyes narrower than the second row (40/43), slightly procurved, median eyes larger than the lateral, and closer to the lateral than to each other. Eyes of the second row further apart than the diameter of one of them (17/13). Posterior row of eyes broader than the second row (57/43), much narrower than the width of the carapace at that point. Quadrangle of posterior eyes broader than long (57/45). Clypeus higher than the diameter of the anterior median eyes (9/7). Chelicerae armed with three teeth on the lower margin. Legs moderately stout, tibiae with 2-2-2 spines below, the last pair apical, the posterior tibiae with basal and submedian spines above. Tibia and patella I, 5.15 mm. long. Tibia and patella IV, 8.71 mm. long. Epigynum as figured.

Type locality.—China: female holotype from Shanghai, collected by the National Geographic Society Expedition under F. R. Wulsin, August, 1922. Type: U. S. N. M. Cat. No. 1138.

Lycosa chapini, n. sp.

Female: Total length, 14.35 mm. Carapace, 7.12 mm. long, 5.74 mm. wide. Abdomen, 7.22 mm. long, 5.05 mm. wide. Carapace brown, anteriorly with a light reddish brown design consisting of a thin median line extending from the posterior lateral eyes to the dorsal groove, and a short but wide transverse bar crossing this, giving off at its ends two thin lines which meet forming a point with the median line. Sides of the carapace brown with submarginal light bands having irregular edges and frequent interruptions. Clypeus reddish brown with dark discolorations below the lateral eyes. Chelicerae densely covered with long hairs. Sternum, labium, and endites brown with lighter edges. Sternum with a lighter central area. Dorsum of the abdomen reminiscent of *Pardosa* having a black mottled ground on which are four pairs of indistinct light spots with black centers. Venter pale or reddish. Legs brown, femora with four rings, rest of the joints indistinctly annulate.

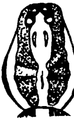
First row of eyes narrower than the second (31/37), slightly procurved, medians larger, somewhat closer to the laterals than to each other. Eyes of the second row their diameter apart. Third row of eyes wider than the second (55/36). Clypeus high, about one and one-half the diameter of the anterior median eyes. Chelicerae armed with three teeth on the lower margins. Legs tapering from the proximal to the distal ends, tibiae with 2-2-2 spines below, the last pair apical. Tibia and patella I, 8.12 mm. long. Tibia and patella IV, 9.21 mm. long. Epigynum as figured.

Type locality.—China: female holotype from Kunghsien south of Suifu, Szechwan Province, April 3, 1930; three female paratypes from Tatsientu, Szechwan Province, July 20, 1923. Type and paratypes: U. S. N. M. Cat. No. 1139.

Lycosa chengta, n. sp.

Female: Total length 11.00 mm. Carapace, 4.55 mm. long, 3.66 mm. wide. Abdomen, 6.43 mm. long, 2.57 mm. wide. Carapace brown, medially with a light central orange band as wide as the third row of eyes. A short tongue-like projection from this band goes forward between the eyes of the third row to a point midway between this row and the second eye row. At the dorsal groove the band has irregular edges; posteriorly it tapers to a narrow stripe. Sides of the carapace brown, the margins black with wide submarginal light bands. Sternum and labium dark brown, endites and coxae lighter. Legs light brown; femora with annulations. Dorsum of the abdomen brown, medially with several pairs of light brown spots with black centers arranged in series. Venter the same color as the dorsum.

First row of eyes narrower than the second (21/29), straight, the medians larger and closer to the laterals than to each other. Eyes of the second row their diameter apart. Third row of eyes wider than the second (36/29), and much narrower than the carapace at that point. Quadrangle of posterior eyes broader than long (36/26). Clypeus one and one-half times as high as the diameter of the anterior median eyes. Chelicerae with three teeth on the lower margin. Legs slender, the tibiae armed with 2-2-2 spines below, the last pair apical, the posterior tibiae with basal and submedian spines above.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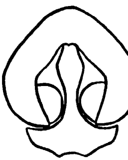
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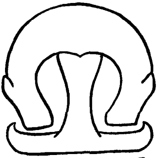
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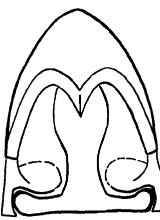
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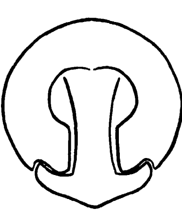
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Fig. 1.—*Lycosa subcoelestis*, n. sp., carapace. Fig. 2.—*Arctosa gertschi*, n. sp., male palpus, ventral view. Fig. 3.—*Lycosa grahami*, n. sp., epigynum. Fig. 4.—*Lycosa wulsini*, n. sp., epigynum. Fig. 5.—*Lycosa chengta*, n. sp., epigynum. Fig. 6.—*Lycosa chapini*, n. sp., epigynum.

Tibia and patella I, 5.24 mm. long. Tibia and patella IV, 6.03 mm. long. Epigynum as figured.

Type locality.—China: female holotype and three female paratypes from Chengtu, Szechwan Province, 1200 feet, April 1, 1930. Type: U. S. N. M. Cat. No. 1140.

Lycosa coelestis L. Koch

Lycosa coelestis L. Koch Verh. Zool-Bot. Gesell. Wien **27**: 772, pl. XVI, figs. 35, 36. 1877.

Records.—China: Szechwan Province, Suifu, 1000 feet, May, 1924, 3 females and 2 males; June, 1925, one female; May, 1930, one female.

Lycosa grahami, n. sp.

Female: Total length, 14.35 mm. Carapace 7.62 mm. long, 5.94 mm. wide. Carapace reddish brown in the alcoholic specimen, showing signs of a lighter median longitudinal band. Sides of the carapace edged with black. Sternum, labium, endites, and coxae blackish brown. Legs reddish brown with longitudinal black stripes at the lateral faces. Abdomen (shrivelled in the specimen) black.

First row of eyes narrower than the second (30/34), slightly procurved, the eyes subequal with the medians closer to the laterals than to each other. Second row narrower than the third (34/49), the eyes more than their diameter apart Quadrangle of posterior eyes wider than long (49/36). Clypeus much higher than the diameter of the anterior median eyes (9/5). Chelicerae with three teeth on the lower margins. Legs moderately stout, tibiae with 2-2-2 spines below, the last pair apical. Tibia and patella I, 7.33 mm. long. Tibia and patella IV, 7.92 mm. long. Epigynum as figured.

Type locality.—China: female holotype from Chaotung, Yunnan Province, 1925. Type: U. S. N. M. Cat. No. 1141.

Lycosa pseudoannulata (Bosenberg and Strand)

Tarentula pseudoannulata Bosenberg and Strand Abh. Senckenb. Naturf. Gesell. **30**: 319, pl. 8, fig. 106; pl. 13, figs. 323, 326, 334, 338. 1906.

Records.—China; Szechwan Province, Suifu, 1000 feet, many females, males, and immatures taken November 25, 1929, October 15, 1930, and June, 1930; Kuanshien, 2000 feet, March 2, 1930, females; Kunghsien, 1200 feet, April 3, 1930, males and females; Chengtu, 1200 feet, April 1, 1930, females; Yunnan Border, 6000 feet, October, 1928 males, females, and immatures.

Lycosa subcoelestis, n sp.

Female: Total length 10.89 mm. Carapace 5.64 mm. long, 4.45 mm. wide. Abdomen 5.05 mm. long, 4.15 mm. wide Carapace brown with a median longitudinal light brown band which begins at a point midway between the second row of eyes and the third row. This band widens as it progresses backwards, half-way down the cephalothorax it is as wide as the third eye row, here it abruptly narrows to a thin line one-third the width of the anterior portion which widens slightly at the dorsal groove, but narrows again after leaving it. Sides of the carapace brown, the margins dark, with submarginal light bands. Sternum and endites light brown, the labium darker, coxae and the other joints of the legs clear light brown. Abdomen orange at the sides, medially with a narrow light brown, basal band extending almost one-half the total length of the abdomen; at its caudal end this

band bears two light spots on each side. Posterior portion of the abdomen with numerous yellow spots scattered in the dark field. Venter orange.

First row of eyes as wide as the second, straight, the medians larger, and closer to the laterals than to each other. Eyes of the second row their diameter apart. Third row of eyes broader than the second (35/26), and much narrower than the carapace at that point. Quadrangle of posterior eyes wider than long (35/28). Clypeus equal in height to the diameter of the anterior median eyes. Chelicerae with three teeth on the lower margin and strong indication of a fourth one. Legs moderately stout, the tibiae with 2-2-2 spines below, the posterior tibiae with basal and submedian spines above. Tibia and patella I, 4.55 mm. long. Tibia and patella IV, 5.14 mm. long. Epigynum: Similar to that of *Lycosa coelestis* L. Koch.

Type locality.—China; female holotype from Suifu, Szechwan Province; 3 female paratypes from Yachow District, Szechwan Province, 1800 feet, May 1928; 2 female paratypes from the Yunnan Border, 6000 feet; 2 female paratypes from Shin Kai Sei, Mt. Omei, 4400 feet. Type: U. S. N. M. Cat. No. 1142.

This species closely resembles *Lycosa coelestis* L. Koch, but is distinguishable from it by the different designs on the cephalothorax and abdomen (fig. 1), by the light sternum and venter, and by the smaller size. Paratypes from the above localities were smaller than the type by as many as 3 mm. The total length of the females of *L. subcoelestis* varies from 8.5 to 11.5 mm., while that of *L. coelestis* L. Koch ranges from 12 to 15 mm.

Pardosa astrigera L Koch

Pardosa astrigera L. Koch Verh. Zool-Bot. Gesell. Wien **27**: 775, pl. 16, figs. 37, 38. 1877.

Records.—China: Szechwan Province, Suifu, 1000 feet, May 1928, 3 females; Yachow District, 1800 feet, May, 1928, female.

Pardosa laura Karsch

Pardosa laura Karsch Verh. Ver. Rheinl. **36**: 102, pl. 1, fig. 21. 1879.

Records.—China: Szechwan Province, Suifu, 1000 feet, June 1925, female; May, 1928, 3 females; Shin Kai Sei, Mt. Omei, 4000 feet, August 7, 1929, female; Yachow District, 1800 feet, May, 1928, female; West of Yachow, 2000 feet, June, 1923, male.

Mature females have distinct annulations on the legs, which is in accordance with Karsch's original description The annulations of the legs of males, however, are indistinct and sometimes obsolete.

Pirata clercki (Bosenberg and Strand)

Tarentula (*Piratica*) *clercki* Bosenberg and Strand Abh. Senckenb. Naturf. Gesell. **30**: 316, pl. 8, fig. 107; pl. 13, fig. 320. 1906.

Records.—China: Szechwan Province, Suifu, 1200 feet, April 1, 1930, 2 females; Kunghsien, 1200 feet, April 3, 1930, five females; Chungking, 6000 feet, September 20, 1930, 2 females.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

1077th meeting

The 1077th meeting was held in the Cosmos Club Auditorium, January 5, 1935, President Gish presiding.

An address entitled *The frontiers of aerodynamics*, illustrated by slides, was delivered by the retiring President H. L. Dryden. This address was published in this Journal **25**: 101–122, 1935.

1078th meeting

The 1078th meeting was held in the Cosmos Club Auditorium, Saturday, January 19, 1935, President Gish presiding.

Program: Paul Smith: *Ray paths of sound in deep sea water.*—During 1933 and 1934, experiments were made by the U. S. Coast and Geodetic Survey to determine the horizontal path of sound through sea water, and valuable information has been obtained. The ships *Pioneer* and *Guide* on the Pacific Coast operated in depths of about 1000 fathoms and many oscillograph and chronograph records were made of small bombs fired near the surface and to depths of 600 fathoms, with distances from 16 to 48 kilometers between ships. On the Atlantic Coast, the ships *Oceanographer* and *Lydonia* experimented with both ships in depths of 1450 fathoms and again with one ship stationed at 793 fathoms while the other steamed toward shore into shoal water. In the Atlantic Coast experiments, time intervals were measured only by chronograph The records of these experiments show that up to certain distances the bomb signal may be received by difracted paths and also by reflected paths between the bomb and the hydrophone. The experiments have given data of great value for the purpose of increasing the accuracy of radio acoustic ranging (*Author's abstract.*)

Herbert G. Dorsey: *The Dorsey fathometer.*—To be published in this Journal.

These papers were discussed by Messrs. Gish, Stimson, Humphreys, Curtis, McNish and Rude.

1079th meeting

The 1079th meeting was held in the Cosmos Club Auditorium, February 2, 1935, President Gish presiding.

Program: L. S. Taylor: *The problem of measurement of x-rays and gamma-rays.*

F. L. Mohler: *Bactericidal effects of x-rays.*—When an X-ray quantum is absorbed by matter the entire energy is given to a single electron. This high-speed electron gradually dissipates its energy leaving a trail (column) of ions behind it. In liquids and solids the density of ionization in these columns is so great that nearly all the ions recombine and the effects are strictly limited to the columns of ionization. The theory proposed is that killing bacteria depends simply on the chance that a column of ionization passes through the cell or a certain part of the cell and the probability is expressed in terms of the effective collision area S for a fatal encounter. If this is true then the fraction surviving an exposure of time t will be $A(t)/A_0$

$=e^{-at}$. Wyckoff and Rivers[1] studied first the killing of bacteria by 155 kv cathode rays. A dilute culture of colon bacilli was flowed over a surface of agar jelly and exposed to a measured current of cathode rays. After an incubation period a count of the colonies gave the survival ratio which depended on exposure time according to the exponential law. If S is the area sterilized by each cathode ray then nS is the fraction of the area sterilized by a flux of n cathode rays per second and nS can be equated to a. The resulting value of S is $.76\times 10^{-10}$ cm.[2] The bacilli are short rods with cross sections of the order of 10^{6} cm^2 so the vital spot is a small part of the bacillus.

Wyckoff has published comparable measurements of the killing of colon bacilli by characteristic soft X-rays of different wave lengths. In this case the dosage in r units is given. From this one can estimate the number of quanta n absorbed per cm^3 per sec. in the agar. Each fast electron goes a distance x and sterilizes a volume Sx. Equating nSx to a gives values of S which vary somewhat with the X-ray wave length. Wave lengths of .56 and .70A give values nearly the same as for cathode rays, viz. $.7\times 10^{-10}$ cm^2. Wave lengths ranging from 1.5 to 4A give values from 1.9 to 2.6×10^{-10} cm^2. The density of ionization is very much greater for the longest wave lengths so that the effectiveness in terms of r units is much less for the longest wave lengths.[2] (*Author's abstract.*)

F. O. COE: *Opaque media in clinical roentgenography.*—After the first few months of the use of Roentgen rays in medicine one of the early writers concluded that Roentgenographic methods would be of some value in the following conditions: (1) foreign bodies imbedded in any of the soft tissues of the body; (2) foreign bodies in certain of the organs and viscera; (3) foreign bodies found within the body itself. (4) inflammatory swellings and new growths; (5) fractures and dislocations.

In Roentgen's first two classical communications he reported his findings on the absorption of X-rays by a large number of metals and other substances. Roentgen had noted that lead, gold and heavier metals were opaque to the rays he was using, while some of the lighter metals and some organic substances were much less so.

Dr. Williams of Boston suggested the use of bismuth subnitrate mixed with food in the fluoroscopic examination of the esophagus, and thus was created the prototype of all subsequent diagnostic procedures in the esophagus.

Immediately following the first experiments bismuth subnitrate meals were used in the examination of the stomach. Cannon then gave dogs and cats bismuth with their meals and did his classical research on the gastrointestinal tract. About 1917 barium sulphate was substituted and has since been in use. This media complies with all of the necessary requirements. It is of high atomic weight, is easily obtained in a pure form, is non-toxic and is inexpensive.

Because of their high atomic weight and lack of toxicity in certain chemical combinations the substances now being commonly used are barium sulphate; iodine in many combinations; and thorium in several forms.

The law governing the absorption of Roentgen rays in general is that the absorption is directly proportioned to the fourth power of the atomic number.

These opaque substances used in clinical Roentgen diagnosis have been administered in two ways: (1) By direct introduction into the hollow viscera, either by swallowing them or by injection, (2) those given by mouth

[1] J. Exp. Med. 51: 921. 1930.
[2] J. Exp. Med. 52: 435. 1930.

or intravenously, and then selectively excreted or absorbed in certain organs.

The element of danger in the use of Roentgen rays has been recognized and largely overcome. The present problem is the refinement and extension of available methods and of more importance, the correct interpretations of the many variations from the normal pattern. (*Author's abstract.*)

These papers were discussed by Messrs. TUCKERMAN, WENNER, GISH, HUMPHREYS, MAXWELL, CURTIS and KRACEK.

1080TH MEETING

The 1080th meeting was held in the Cosmos Club Auditorium, February 16, 1935, President GISH presiding.

Program: F. B. SILSBEE: *Superconductivity at radio frequencies.*—The results of measurements made in the temperature range 2.5°K to 4.2°K on the electrical resistance of wires of tin and of tantalum were reported. These showed that the temperatures at which half of the resistance had vanished were the same for alternating currents of frequencies up to 10^6 cycles per second as for direct current. The effective resistance when the specimens were well below their transition temperatures were too small to detect even at radio frequencies by the calorimetric and electrical methods tried.

Experiments in which alternating current of 200 kilocycles per second was superposed on direct current in a tin wire showed a component of potential difference having a frequency of 400 kilocycles per second. The magnitude of this component, and its variation with temperature and with the values of the currents, indicated that the specimen must have been fluctuating in resistance cyclically as a result of the cyclic disturbance of the superconducting condition by the magnetic field of the currents. (*Author's abstract.*)

F. G. BRICKWEDDE: *The uses of deuterium and the measurement of its vapor pressures.*—Published in this JOURNAL **25**: 157–166, 1935.

These papers were discussed by Messrs. IVES, GISH, KRACEK, MCNISH, TUCKERMAN, ROESER, SWINGLE and others.

Informal communication.—H. L. DRYDEN presented the Society with a gavel made from historic wood, by M. LANGE of the National Bureau of Standards, and inscribed as follows: "This gavel was made from timbers placed in the White House in 1816 and removed in 1927."

1081ST MEETING

The 1081st meeting was held in the Cosmos Club Auditorium, March 2, 1935, President GISH presiding.

Program: L. V. BERKNER: *Ionosphere observations at the department of terrestrial magnetism of the Carnegie Institution of Washington.*—Exploration of the ionization of the earth's upper atmosphere or *ionosphere* are made possible by the transmission of radio waves and observation of the reflections returned. Methods have been devised which allow the recording of the state of this ionization through the whole height of the region. Observations by these methods have been made in both the northern and southern hemispheres and give generalized ideas concerning the ionosphere.

Two general regions of ionization are found at night. The lowest or E-region ionization exists at about 100 km. The highest or F-region ionization is observed above 250 km. With sunrise, the ionization of both regions increases rapidly. If the latitude is such that the sun approaches within about 40° of the zenith at noon, the F-region separates into two ionized regions.

The lower of these, the F_1-region falls to about 180 km. while the upper or F_2-region rises to above 300 km. As a result, the F_2-region appears as a bulge roughly circular in area under the sun, with the F_1-region beneath it and depressed below the level of the surrounding F_2-region, with the two layers merging together at zenith angles of about 40°.

The maximum ionization of the E- and F_1-regions varies with the altitude of the sun, and this consideration together with the data obtained during the solar eclipses shows that the chief ionizing agency must be ultra-violet light. The maximum ionization of the F_2-region starts to rise with sunrise, but if the sun reaches high altitudes, the rise ceases or a decrease occurs near noon, with a rise to a maximum in the afternoon or evening. A great variability in maximum ionization of the F_2-region ionization occurs from day to day. These interesting and complex effects cannot be explained as a simple function of the altitude of the sun, as is the case with the lower layers. It is significant that such variability should occur in the region of the atmosphere most directly exposed to the sun, above which the absorption of the sun's rays is small.

Sources of ionization other than ultra-violet light are known to be present in the lower region between 100 and 150 km. This is evidenced by sudden increases in ionization to abnormal values which may occur at any time during the twenty-four hours Such ionizations have been shown to be local rather than general in extent.

There is also some evidence that intermediate regions of ionization may exist between the E- and F-regions, but it is difficult to determine whether such regions actually exist separately, or whether the effects may be due to an inhomogeneity of ionization of the whole region of ionization which must extend upward from the E-region to the F-region. The evidence for very high night layers is also considered, but the data is not sufficiently complete to reach any conclusion, as such effects might arise from other causes. (*Author's abstract.*)

E. O. HULBURT: *Theory of the ionosphere.* The atmosphere above about 180 km. is heated by the absorption by molecular oxygen of the spectral region from 1200 to 1800A of sunlight. Calculation indicates that the temperature of the atmosphere from 180 to 300 km may increase 50° per hour in the daytime, which causes molecular oxygen, and possibly nitrogen, to dissociate into atoms. Due to the heating and dissociation there is a marked daily expansion, and nightly contraction, of these outlying levels.

For a static atmosphere, with no motion, winds or diffusion, the density y of the ionization of any region during the day is related to the zenith angle Z of the sun approximately by

$$y = y_0\sqrt{\cos Z} \qquad (1)$$

if the recombination coefficient of electrons and positive ions is of the form given by the three body collision theory of Sir J J Thomson, and if the ultra-violet light of the sun is the cause of the ionization.

The recently published ionosphere data of the National Bureau of Standards and the Department of Terrestrial Magnetism of the Carnegie Institution are the most comprehensive and accurate which have yet been obtained and constitute the first approach to a world-wide survey of the ionosphere.

The E *region.*—The hourly average values of y of E agree closely, within 10 per cent, with (1) throughout the year, showing that the solar ultra-

violet light is the cause of the ionization and, as expected from theory, that diffusion is unimportant. Sporadic variations of y may be due to winds and to the liberation of energy by excited atoms and molecules.

The F_1 *region.*—The observed diurnal and seasonal curves of y of F_1 are somewhat flatter than those given by (1). Diffusion of the ionization seems adequate to account for the difference between the observed and theoretical curves.

The F_2 *region.*—For F_2 the ionization caused by solar ultra-violet light is modified by the daily expansion of the atmosphere above 200 km. and by the winds which result from the expansion. Omitting details it may be stated that the theory gives qualitative agreement with most of the complex daily and seasonal changes in F_2, such as the double daily maximum of y of F_2 at the equator, the noon winter maximum and the evening summer maximum in temperate regions. (*Author's abstract.*)

These papers were discussed by Messrs. MOHLER, HAWKESWORTH, GISH and others.

Presentation of a paper on *Ionosphere observations of the National Bureau of Standards* was cancelled due to illness of the author.

Informal communications: E. BUCKINGHAM: *The calculation of potential flow in aerodynamics.*

H. C. DICKINSON: *The statistical distribution of actual incomes as compared to the presumably random distribution of earning ability.*

1082ND MEETING

The 1082nd meeting was held in the Cosmos Club Auditorium, March 16, 1935, President GISH presiding.

Program: G. GAMOW: *The problems of beta-ray disintegrations.*—Experiments on the beta rays emitted from the radioactive elements have shown that beta particles, as ejected from the nucleus, have a continuous distribution in energy, whereas alpha particles emitted in both preceding and subsequent transformations show discrete energy values. The continuous spectrum of beta rays implies an infinity of isomers while the discrete alpha-particle energies suggest that all nuclei of the same isotope are identical.

Two hypotheses have been suggested for explaining this paradox. The first, by Bohr, escapes the beta-ray difficulty by relinquishing the Law of Conservation of Energy for interactions of beta particles at distances comparable to nuclear dimensions, since these are below the critical limit for which Dirac's theory is applicable. However, Landau has shown that Bohr's hypothesis encounters difficulties when considered from the viewpoint of general relativistic gravitation theory.

The second hypothesis, proposed by Pauli, assumes the existence of particles of zero charge, and of mass comparable to the electron, and that these particles (called *neutrinos*) are emitted at the same time as the beta particle in such a way that the sum of the energies of charged and uncharged particles is constant. The *neutrino* hypothesis appears to be most attractive at the present time, especially since it is also of value in clarifying problems in the apparently unrelated field of spectroscopy. The fact that such *neutrinos* have not been observed experimentally cannot be taken as strong evidence against their existence since their properties are such as to render them practically unobservable. (*Author's abstract.*)

The lecture was discussed by Messrs. KRACEK, GISH, WHITE, TUCKERMAN, BRICKWEDDE, ROESER, GIBSON, MCNISH, SEEGER and HAFSTAD.

1083RD MEETING

The 1083rd meeting was held in the Cosmos Club Auditorium, Saturday, March 30, 1935, President GISH presiding.

The program consisted of the fifth Joseph Henry lecture by P. R. HEYL on the subject *What is electricity*. This lecture was published in this JOURNAL 25: 201–220, 1935.

1084TH MEETING

The 1084th meeting was held in the Cosmos Club Auditorium, April 13th, 1935, Vice-President HECK presiding.

Program: G. B. SCHUBAUER: *Turbulence and its relation to the diffusion of heat.*—The turbulent condition of the air in a wind tunnel is one of the factors which makes the wind in a wind tunnel unlike a natural wind and also unlike the wind created by motion through still air. Because of this fact, much attention has been given to the effect of turbulence on aerodynamic forces and to methods of measuring the amount of turbulence itself. One means of expressing the amount of turbulence in a stream is to use the root-mean-square of the speed fluctuations introduced by the turbulent motions. This quantity, usually divided by the average speed and expressed as a percentage, is often correlated with the various effects of turbulence.

Since the apparatus necessary for the measurement of percentage turbulence is quite complicated and requires considerable skill on the part of the operator, it is desirable to find some simpler measuring device which if desired might be calibrated in terms of percentage turbulence. In the search for such an instrument, a study was made of the diffusion of heat from a platinum-iridium wire, 0 002 inches in diameter and 3 inches long, placed at right angles to a stream which was made turbulent by placing ahead of the platinum-iridium wire, wire screens of various mesh size. The temperature distribution at a given distance behind the wire in the sheet of heated air carried down stream from the wire was found to be greatly affected by the amount of turbulence in the stream. The temperature distribution was determined by a thermocouple connected to a sensitive galvanometer. The width of the temperature distribution curve at half maximum temperature was selected to characterize the width of the heated sheet; and the part of this width remaining after deducting the width due to the thermal conductivity of the air was found to be a function of percentage turbulence alone, regardless of the scale or eddy size of the turbulence.[1] For this reason the width of the temperature distribution curve at half maximum temperature is a satisfactory substitute for percentage turbulence.

A study of diffusion by turbulent motions such as outlined here offers a promising field for future research both in theory and experiment. (*Author's abstract.*)

W. RAMBERG: *Propeller vibrations and propeller failures.*—The recurrence of propeller failures resulting in serious damage and sometimes in loss of life has led to numerous investigations into the causes of such failures. It was seen that failures took place at relatively low design stresses. At the same time the appearance of the fractures with their successive zones of failure supported the view that alternating stresses were the cause of failure. The generation of sufficiently intense alternating stresses could be explained only by resonance vibrations most probably sustained by periodic variations in

[1] SCHUBAUER, G. B. *A turbulence indicator utilizing the diffusion of heat* Technical Report, No. 524, N.A.C.A., 1935.

the driving torque. The problem resolves itself into a study of the stresses set up in a propeller vibrating at a natural frequency.

The speaker reviewed briefly the work on this problem done outside the National Bureau of Standards. He then described in some detail the method of investigations used in that Bureau. He showed the electrical set-up used for exciting full-sized non-rotating propeller blades to resonant vibrations and explained the method of measuring the amplitude of these vibrations and also the stresses at the surface of the blade. A number of stress distributions obtained experimentally were shown and it was indicated that these served as an explanation of the mid-blade failures and tip failures in service.

The measured stress distributions were shown to agree satisfactorily with those computed theoretically upon the assumption that the propeller blades vibrated as a cantilever beam of variable section. A further check on the correctness of the observed results was obtained by noting that eight blades vibrated without rotation at relatively high tip amplitude, eventually developed a fatigue crack at a point where the stresses were within a few percent of the measured maximum stresses.

In conclusion the speaker pointed out some of the problems yet to be solved to explain service failures of propellers. He also demonstrated a model showing an extension of the electrical method of excitation used at the Bureau of Standards to set up vibration in a rotating propeller. (*Author's abstract.*)

The papers were discussed by MUNK, DRYDEN, TUCKERMAN, HAWKESWORTH, BRICKWEDDE, HECK, and others.

1085TH MEETING

The 1085th meeting was held in the Cosmos Club Auditorium, May 11, 1935, President GISH presiding.

Program: M. A. TUVE: *Some recent developments in high-energy physics.*—The speaker outlined the problems in this field which had been discussed at the Conference on Theoretical Physics recently held in Washington under the joint auspices of the George Washington University and the Carnegie Institution. Of the questions considered at this Conference, the following appeared to be of outstanding importance: (1) magnetic moments of the fundamental particles (2) emission of dipole or quadriipole radiation (3) interaction forces of particles (4) mechanism of capture of slow neutrons (5) energy conservation in beta-ray disintegrations (6) correction of the Aston Mass Scale (7) failure of Maxwells equations at high energies.

Discussed by Messrs. TUCKERMAN, KRACEK, ADAMS, HAFSTAD and others.

Informal communications: L. B. TUCKERMAN.—Experiments he had performed whereby material specimens placed under heavy hydrostatic pressures showed tension fractures were described. Sample test specimens were exhibited.

Discussed by TUVE, ADAMS and others.

A radio broadcast address by L. J. Briggs on the 1935 stratosphere flight was also presented as an informal communication.

L. R. HAFSTAD, *Recording Secretary*

1086TH MEETING

The 1086th meeting was held in the Cosmos Club Auditorium May 25, 1935, Vice-president WENNER presiding.

Program: PAUL H. EMMETT: *Adsorption and catalytic conversion of ortho-to para-hydrogen over iron synthetic ammonia catalysts.*—A combined study of

the adsorption of hydrogen on iron catalysts and of the influence of pressure, temperature and poisons on the catalytic ortho-para hydrogen interconversion over iron has been made. The experiments show the existence of at least three types of adsorption of hydrogen on the surface of iron synthetic ammonia catalysts, a physical or van der Waals' adsorption at $-190°$ to $130°$, a low temperature (type A) activated adsorption between $-90°$ and $0°$, and a higher temperature (type B) activated adsorption at and above 100°C. The temperature coefficient of the orthopara interconversion is positive throughout the range $-190°$ to $60°$, the latter being the highest temperature used. The apparent energy of activation became progressively larger as the temperature increased, rising from a few hundred calories at $-190°$ to about 6000 calories at room temperature. The time for half conversion increases with the pressure both at $-190°$ and at higher temperatures. The low temperature ($-190°$) conversion is presumably associated with the van der Waals' adsorption. At $-78°$ the rate of conversion begins to increase rapidly with temperature and is apparently brought about by type A activated adsorption. The conversion at $-190°$ is strongly poisoned by either the type A or type B activated adsorption, the latter being about 8 times as poisonous per unit volume adsorbed as the former. (*Author's abstract.*)

Discussed by Messrs. BUCKINGHAM, HAWKESWORTH, HUMPHREYS, TUCKERMAN, BRICKWEDDE, GIBSON and CURTIS.

Informal communication: F. G. BRICKWEDDE and R. B. SCOTT (presented by F. G. BRICKWEDDE): *The vapor pressure of hydrogen deuteride.*—Hydrogen deuteride (HD) was separated by distillation from 4 liters of an equilibrium mixture of H_2, HD and D_2, containing equal parts of hydrogen and deuterium, using a still with a reflux rectification column, immersed in liquid hydrogen. There were obtained 500 cm^3 of HD of purity 99.95 percent

TABLE 1.—VAPOR PRESSURE OF HYDROGEN DEUTERIDE

Temperature, °K	Vapor Pressure in mm of Hg		Latent Heat of HD in cal/mol	
	H_2	HD	Vaporization	Fusion
22.13[a]	1230	760.0		
20.38	760.0	438.0	261	
16.60[b]	201.4	93.6	265 (liquid)	37
16.60	201.4	93.6	302 (solid)	
13.92	54.0	15.96	296	

[a] Obtained by extrapolating the vapor pressure equation to $P(\mathrm{HD}) = 760$ mm
[b] Triple Point.

or better as estimated by a comparison of its vapor pressure with that of two fractions collected immediately before and after. The vapor pressure of this *pure* HD was compared with that of liquid normal H_2 in the range 13.92 to 20.38°K. The following empirical equations were obtained, expressing pressures in mm of Hg:

$$\log_{10}P(\mathrm{HD\ liquid}) = -0.85411 + 1.27713 \log_{10}P(H_2) - 0.02212 \log_{10}^2 P(H_2)$$

$$\log_{10}P(\mathrm{HD\ solid}) = -1.11571 + 1.33969 \log_{10}P(H_2)$$

Using the Clapeyron equation and the equation of state of H_2 for HD, latent heats were calculated from the above equations for HD, and the vapor pressure-temperature equation of normal hydrogen.

After 15 days there was no reversion to the equilibrium mixture of H_2, HD and D_2 that could be detected by a change in vapor pressure. (*Author's abstract.*)

Discussed by Messrs. Gibson, Hawkesworth, Buckingham, Seeger, Stimson and Tuckerman.

F. B. Silsbee, *Acting Recording Secretary*

SCIENTIFIC NOTES AND NEWS

Prepared by Science Service

Notes

Washington Scientists at International Congresses.—Numerous Washington scientists served as official delegates of the United States Government at various international congresses held in Europe during the past summer and autumn. A partial list follows:

Sixth International Botanical Congress, Amsterdam, September 2 to 7: Dr. G. H. Coons, Mr. T. P. Dykstra, Dr. A. S. Hitchcock, Mr. B. Y. Morrison and Dr. Neil E. Stevens, all of the U. S. Department of Agriculture, and Mr. Ellsworth P. Killip, of the U. S. National Museum.

Twelfth International Congress of Zoology, Lisbon, September 15 to 21: Dr. Leonhard Stejneger, U. S. National Museum, and Dr. Charles W. Stiles, Smithsonian Institution.

Third Conference of the International Society of Soil Science, Oxford, July 30 to August 6: Dr. C. E. Kellogg, Dr. W. C. Lowdermilk, Dr. A. G. McCall and Dr. Oswald Schreiner, all of the U. S. Department of Agriculture.

Sixth International Congress on Entomology, Madrid, September 6 to 12: Dr. Leonhard Stejneger, U. S. National Museum, and Mr Lee A. Strong, U. S. Department of Agriculture.

Fourth International Technical and Chemical Congress of Agricultural Industries, Brussels, July 15 to 28: Dr. Atherton Seidell, U. S. Public Health Service, and Dr. James M. Doran, Distilled Spirits Institute.

Fourteenth Session of the Medical Days of Brussels, Brussels, June 29 to July 3: Maj. Edgar E. Hume, Medical Corps, U. S. Army, and Medical Director C. C. Pierce, U. S. Public Health Service.

Celebrations of Centenary of Geological Survey of Great Britain, London, July 3 to 5: Dr. Arthur L. Day, Carnegie Institution of Washington.

Seventh International Congress on Industrial Accidents and Occupational Diseases, Brussels, July 22 to 26: Dr. C. C. Pierce, U. S. Public Health Service, and Mr. William G. Rice, Division of Labor Statistics.

First International Congress of Gastro-Enterology, Brussels, August 8 to 10: Lt. Col. John H. Trider, Medical Corps, U. S. Army, Dr Ray L. Sexton and Dr. William G. Morgan.

Twelfth International Congress on Pharmacy, Brussells, July 30 to August 5: Maj. Edgar E. Hume, Medical Corps, U. S. Army.

Meetings in Ibero-American Countries.—Washington scientists also attended inter-American gatherings held in the capitals of our neighbor republics to the south. Among these were:

Seventh American Scientific Congress, Mexico City, September 8 to 17: Dr. CLOYD H. MARVIN, President, George Washington University, Dr. NEIL M. JUDD, U. S. National Museum, and Dr. FRANCE V. SHOLES, Carnegie Institution of Washington.

Third Pan American Red Cross Conference, Rio de Janeiro, September 15 to 25: Rear Admiral CARY T. GRAYSON, Chairman, American National Red Cross, and Dr. THOMAS W. GOSLING, Director, American Junior Red Cross.

National Committee on Inter-American Intellectual Cooperation.—A National Committee to cooperate with the Division of Technical and Scientific Exchange of the Pan American Union was recently established and its sixteen members appointed by the Secretary of State, under the Chairmanship of Mr. JOHN W. STUDEBAKER, Commissioner of Education in the Department of the Interior. The action was taken to carry out the terms of resolutions adopted by the Seventh International Conference of American States that met in Montevideo, Uruguay, in December, 1933. Those resolutions had for their general theme the promotion of such measures as would facilitate scientific and technical interchange among the American countries in order to raise the cultural level and in general to further the advancement of the peoples of the Western Hemisphere.

Water Resources Committee.—Water resources of the United States are to be planned on a basis of national use, by a newly appointed committee which will deal with PWA projects involving any use or control of water or resources dependent on water. The scope of the committee's activities will include power, flood control, erosion, wildlife conservation, and a number of other problems. The personnel includes: ABEL WOLMAN, chairman of the Maryland Planning Board; THORNDIKE SAVILLE, of the American Society of Civil Engineers and associate dean of the College of Engineering, New-York University; N. C. GROVER, chief hydraulic engineer, water resources branch, U. S. Geological Survey; ELWOOD MEAD, director of the Bureau of Reclamation; JAY N. DARLING, chief of the biological Survey; H. H. BENNETT, chief of the Soil Conservation Service; R. Y TARBETT, sanitary engineer, U. S. Public Health Service; Maj. Gen. EDWARD M. MARKHAM, chief of the U S. Army Engineer Corps; THOMAS R TATE, director of the National Power Survey, Federal Power Commission; H. H BARROWS, professor of geography at the University of Chicago and formerly a member of the Mississippi Valley Committee and the National Resources Committee; EDWARD HYATT, state engineer, California.

National Bureau of Standards.—Mr. E. C CRITTENDEN, Assistant Director of the National Bureau of Standards, sailed from Baltimore on September 5 to attend a meeting of the advisory committee on electricity appointed by the International Committee on Weights and Measures. This meeting was held at Sevres and Paris the week of September 23. The meeting of the advisory committee was followed by the regular biennial session of the International Committee, of which the American member is Prof. A. E. KENNELLY of Harvard University.

U. S. National Park Service.—Director ARNO B. CAMMERER left Washington in late August for the West, accompanying members of the Committee on Public Lands and Surveys of the Senate on an inspection tour of national park projects. Mr. BEN H. THOMPSON, formerly of the Wildlife Staff and now special assistant to the Director, is accompanying Director CAMMERER on this trip.

Dr. Carl P. Russell, in charge of Eastern Museum Activities of the Service, will leave Washington in late September for a visit to the Field Division of Education at Berkeley, California. Dr. Louis Schellbach, Assistant to Dr. Russell, will leave Washington at the same time for Berkeley where he plans to remain to direct museum work in western parks and monuments.

Department of Terrestrial Magnetism, Carnegie Institution of Washington. —The establishment of radio communication over an assumed path greater than half the earth's circumference between the radio station at Washington Grove, Maryland, and the Watheroo Magnetic Observatory operated by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington in Western Australia, was reported by the former station on August 21, 1935. Ordinarily communications between the Watheroo Magnetic Observatory and stations in the vicinity of Washington are achieved over paths crossing the Pacific Ocean, some 11,900 miles in length. As the communication referred to above took place between 6:30 and 7:00 P.M., 75th meridian time, it is assumed that the transmission-path was over the eastern portion of the globe, which at that time was in darkness.

H. W. Wells, observer in the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, who for the past three years has been assisting in the program of ionosphere-work at the Huancayo Magnetic Observatory in Peru, returned to Washington on September 5.

News Briefs

Sugar cane produces a "virus-paralyzing" substance in its growing tips, which combats the effects of cane mosaic, Drs. E. W. Brandes and Julius Matz, U. S. Department of Agriculture, reported to the fifth triennial congress of the International Society of Sugarcane Technologists held at Brisbane, Australia, in August. They found that when juice extracted from healthy tissue taken from near the growing tips was mixed with juice from mosaic-sick plants, known to contain the virus, and the mixture then injected into healthy canes, the resulting infection was much less severe than control infections caused by unmixed virus-containing juice.

The Federal study of chronic illness in nineteen "sample" states throughout the country is scheduled to start October 15. The study will be directed by George St. J. Perrott, statistician of the U. S. Public Health Service, under a PWA grant of $3,450,000. Ninety percent of the personnel will be taken from the work-relief rolls of the various states. Some of the information will be obtained from the records of hospitals and sick-benefit associations. The rest will come from a house-to-house canvass of 750,000 families selected as representative of the general population, at various income levels. Besides chronic illness, data will be collected on physical disabilities such as blindness, deafness and loss of limbs. Field headquarters will be in Detroit.

Obituary

WALTER HOUGH, head curator of anthropology at the U. S. National Museum, died at his home, 1332 Farragut Street, N. W., Washington, D. C., September 20, 1935, after a short illness. He was born April 23, 1859, at Morgantown, W. Va. After graduating from the University of West Virginia in 1883, he taught in a boys' school at Alton, Ill., until 1886, when he became an aid in the division of ethnology at the National Museum, rising eventually to the position of head curator of anthropology in 1923. He received the Ph.D. degree from his alma mater in 1894 and was elected to membership in Phi Beta Kappa there in 1914.

Doctor Hough conducted numerous explorations in the Southwestern States, Mexico, and other regions in search of archaeological and ethnological data about the American Indian. The results of these and other researches are embodied in many publications, the chief of which deal with such subjects as aboriginal use of fire, history of illumination, primitive armor, Hopi ethnobotany and pigments, Malayan ethnography. Doctor Hough was twice president of the Anthropological Society of Washington. He was also a member of the Washington Academy of Sciences, American Association for the Advancement of Science, Société d'Anthropologie, Swedish Society of Anthropology and Geography, and a Knight of the Order of Isabella of Spain.

ERNST GEORG FISCHER, formerly chief of the Instrument Division of the Coast and Geodetic Survey, died at Garfield Hospital, Washington, D. C., September 22, 1935. He was born at Baltimore, Md., August 6, 1852. At the age of two he was taken to Dresden, Germany, where he attended elementary schools and studied and worked as an engineer until 1870. He then returned to America taking up private engineering practice. In 1887 Mr. Fischer entered the Instrument Division of the Coast and Geodetic Survey and served as the Chief of this Division until his retirement in 1932. In 1934 the Franklin Institute of Philadelphia awarded him the Howard M. Potts gold medal for "a lifetime spent with marked success in the design of instruments of precision for the United States Coast and Geodetic Survey." A list compiled in 1922 contains 24, including tide gauges, artificial horizon, geodetic level, transit micrometer, pressure sounding tube and most remarkable of all, a tide-predicting machine, which won for him widespread recognition. Mr. Fischer was a member of the Washington Academy of Sciences, the Philosophical Society, the Society of Washington Engineers and the Cosmos Club.

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PHYSICS.—*The Dorsey fathometer.*[1] HERBERT GROVE DORSEY.
U. S. Coast and Geodetic Survey.

The regular type of fathometer (U.S. Patent No. 1,667,540 to the writer), has been used by the United States Coast and Geodetic Survey since 1925 and has proved very valuable in measuring all depths from 15 fathoms to 3,000—the deepest encountered by this Bureau in regular surveying work. This work has all been done by what is called the red light method, in which the depth is indicated by a flash in a rotating neon tube and recorded in the sounding book.

While this type fathometer gave excellent results in depths greater than 15 fathoms, there was need for an instrument of high precision for depths less than 15 fathoms; consequently, in January, 1933, it was decided to develop an instrument primarily for shoal water only, that is, depths no greater than 20 fathoms which would overlap the depths measured by the regular type instrument, and since it is desirable to have a comparatively large number of indications per second it was decided to make the scale from 0 to 20 fathoms and have 20 indications per second, so that there would be indicated a nearly continuous profile of the bottom. In order to get sufficient accuracy, it was decided to use a tuning fork driven by thermionic tubes and drive a synchronous motor from this source. Figure 1 shows schematically the operation of the entire system.

INDICATOR

The indicator consists of the rotor, the stators and a starting motor to bring the rotor up to synchronism. It was considered desirable that the indicator run at its correct speed or not at all. The rotor is run by current taken from the fork circuit and amplified by a pair of power triodes. A tuning fork can easily be kept on its frequency with an error less than 0.1 per cent, and if temperature control of the fork be used, any desired accuracy can be obtained. The forks

[1] Presented before the Philosophical Society, January 19, 1935. Publication approved by the Director of the Coast and Geodetic Survey of the U. S. Department of Commerce. Received July 8, 1935.

used are made of steel having a low temperature coefficient of modulus of elasticity and temperature control is unnecessary since a change of temperature of 30°C makes only about 0.1 per cent change in frequency. By using a frequency of 1025 cycles per second and a stator without polarizing current, a synchronous motor having 100 teeth on the rotor will rotate at a speed of 20.5 revolutions per second.

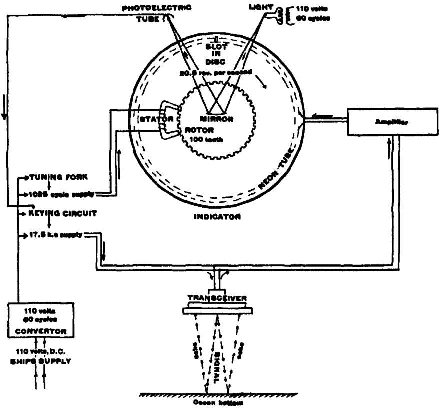


Fig 1.—The Dorsey fathometer, schematic diagram of method of operation.

An annular space in the rotor is filled with mercury to act as a balance. In any method of controlling speed by a governor no correction to the speed can be made until the speed has changed, whereas, with a tuning fork the regulation is almost continuous. With this fork frequency the velocity of calibration is 820 fathoms, or 1499.6 meters, per second. On the same shaft with the rotor is a disk having a narrow radial slot and just back of this disk is a neon tube bent in the form of a circle of 7 inches inside diameter, so that when the neon tube is ionized it will be seen through the slot in the disk. The dura-

tion of this flash is probably not over 2 or 3 millionths of a second, resulting in a brilliant red flash so brief that the slot appears stationary and for a constant depth the indication is so steady that it can be viewed through a magnifying glass and the variation on the scale is less than 1/32 inch. In front of the disk is a glass scale calibrated to 20 fathoms, the fathoms being subdivided into feet. The diameter of the scale is about 8 inches giving a scale length of 25 inches, thus giving 0.2 of an inch for 1 foot of depth or 1.8 centimeters per meter depth for a scale calibrated in the metric system. These divisions can easily be read to tenths so that it is possible to read to tenths of feet or to 10 centimeters on a metric scale. The dial is frosted slightly so that little light is reflected, making the flashes more readily perceptible. At one side near the teeth of the rotor is a small neon lamp, actuated from the 1025 cycle alternating current, giving 2050 flashes of light per second on the teeth, making them appear stationary when the rotor is in synchronism with the tuning fork.

In order to send the signal, contacts were found unreliable, due to chattering, so a small concave mirror is rotated on the shaft to reflect light from an incandescent lamp to a photo-electric tube. The tube and lamp are placed on top of the indicator under small hoods. A slot under the photo-electric tube is adjustable, to correct the position of the flash made at the zero of the scale when the signal is produced, so that the readings may indicate surface depth instead of depth under the ship. Figures 2 and 3 show the front and side of the indicator.

POWER SUPPLY

The electromotive force generated by the flash of light on the photo-electric tube is amplified by a single triode and then changes the grid bias of a thyratron, FG 65, a hot cathode gaseous triode, causing a condenser, with renewable charge, to discharge through the anode-cathode circuit of the thyratron. This discharge current passes through the primary of a transformer, the secondary of which is in the screen grid circuit of a pair of power pentodes in a self-exciting push-pull circuit tuned to a frequency of 17.5 kilocycles. The signal is then amplified by a pair of power triodes in the push-pull circuit and passes to the transceiver. The method of changing the screen grid voltage from about 200 volts negative to 300 or 400 volts positive gives a very short and regular signal. No current is taken by the anode circuit of the tubes until the screen grids become positive, thus economizing the high tension current. This method of

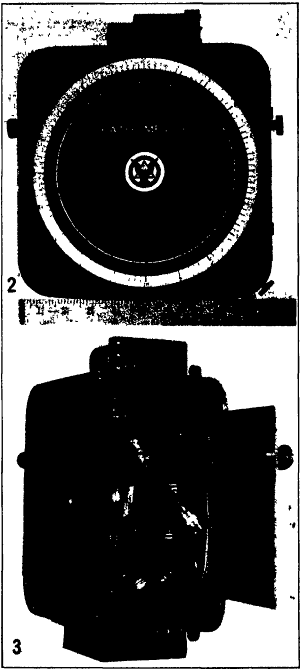


Fig. 2.—Front view of indicator. Fig. 3—Side view with front removed.

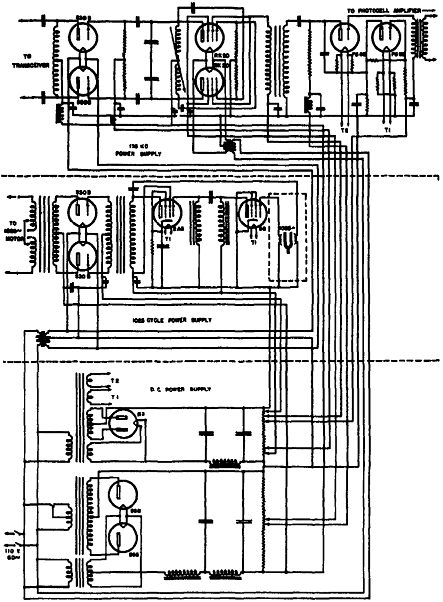


Fig. 4.—Wiring diagram of power supply.

sending the signal has proved very simple and absolutely reliable. With no moving contacts in the indicator, construction and performance are simplified and less energy is necessary to drive the moving parts.

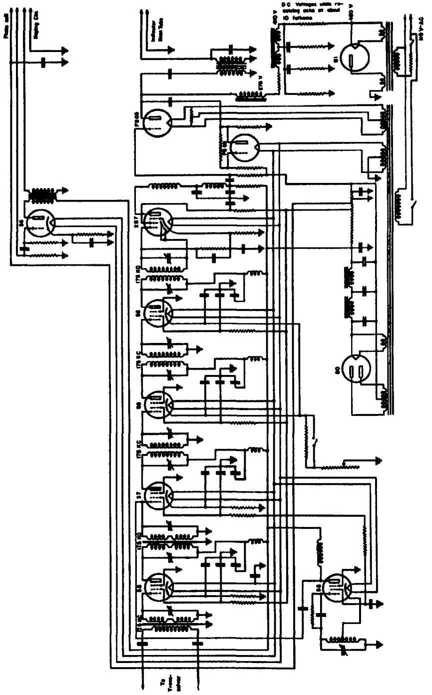


Fig. 5.—Wiring diagram of amplifier.

While it is easier to send on one instrument and receive on another, it was decided to use only one transceiver, so that the scale of the indicator would be uniform throughout; consequently, no matter how shallow a depth is measured, there is no correction due to the longer path required for the sound waves when two separate instruments are used for sending and receiving. Although the difficulties were great at the beginning, the increased effort to use the single transceiver made it worth while to spend the extra time in the development. Figure 4 shows the power supply circuit.

AMPLIFIER

The amplifier consists of a pair of push-pull triple grid tubes as a preamplifier, after which a superheterodyne circuit is used to amplify on an intermediate frequency of 175 kilocycles, after which the signal is rectified and actuates a pair of thyratrons in series through the anode-cathode circuit of which a condenser is discharged, as was described in the keying circuit. The discharge of this condenser through a transformer generates a voltage of about 700, which produces a flash in the circular neon tube back of the rotating disk. The whole apparatus is so sensitive to changes in depth that the indicator registers the differences in depth when a small surveying ship rises and falls on a light swell. Figure 5 shows the amplifier circuit.

The instrument has been used during the last field season for two months on the surveying ship *Lydonia* and about a month on the *Hydrographer*. The ranges of depth measured were from 5 feet to 120 feet. On the *Lydonia* comparisons were made every day for several weeks between the fathometer indications and the lead line to determine if there were any variations between the two methods. It appears that the fathometer indications are more reliable than the lead line, even when the latter is handled by a skilled leadsman of many years' experience. With the ship stopped, the lead line and fathometer indications agree to within a few inches, or as close as can be read, but with the ship under way, there is always a slight difference, the lead line indicating the greater depth by an amount of about one foot. On the *Hydrographer*, the cross sounding lines of the survey show agreement of depth to a few inches with the fathometer, while with hand leading soundings an agreement to within a foot is generally considered satisfactory work.

During the coming season it is expected to use the fathometers on these two ships again and in addition make an installation on the

Tender *Gilbert* and one on a 75-foot launch to determine its operation on small craft.

In this work the writer desires to express his thanks to his assistants, Charles G. McIlwraith, R. B. Wright and Thomas B. Hickley for their numerous valuable suggestions in the development and untiring efforts in the laboratory and at sea; to wireless operators William Smith and G. D. Nedley for their help in maintenance on the *Lydonia* and *Hydrographer;* to Captain Gilbert T. Rude, Chief of the Division of Hydrography and Topography for his continued keen interest and encouragement and to Captain R. S. Patton, Director of the Bureau for his faith in the ultimate outcome of the development and for the honor conferred in naming the instrument the Dorsey Fathometer.

CRYSTALLOGRAPHY.—*Alternating axes and symmetry symbols in crystallography.*[1] J. D. H. DONNAY, Johns Hopkins University. (Communicated by G. TUNELL.)

It is well known that all thirty-two crystal classes cannot be derived if the only symmetry elements used are the plane of symmetry, the center of symmetry, and the rotation axis of symmetry (or axis of symmetry of the 1st kind). Only thirty-one classes are obtained in that manner, the missing one being the tetragonal disphenoidal (or sphenoidal tetartohedral) class of the tetragonal system. Bravais has often been criticized for omitting this possible crystal class in his celebrated *Etudes cristallographiques;* as a matter of fact, he did recognize the possibility of alternating symmetry as he explicitly states that this concept will be deliberately left out of his treatment. From the practical standpoint, the fact that no substance was known at the time to belong to the tetragonal disphenoidal class might have justified Bravais' attitude. On theoretical grounds, however, alternating symmetry must be introduced for the sake of completeness.

Another reason for using this type of symmetry has been given by Austin F. Rogers[2] who redefined symmetry operations as "movements by means of which each and every face of the general form of a crystal may be derived directly from an arbitrarily selected face." The trend of his argument is as follows: (1) the symmetry operations of a general crystal form $\{hkl\}$ have been proved to form a group; (2) the number n of symmetry operations in the group (or the order n of the point-group) is equal to the number of faces of the general

[1] Received November 23, 1934.
[2] AUSTIN F. ROGERS *A mathematical study of crystal symmetry.* Proc Am. Acad. Arts and Sc 61: 161–203 1926

form $\{hkl\}$; (3) by the very definition of a group, the product of any two symmetry operations is also a symmetry operation; hence, (4) in order to emphasize this individuality of each symmetry operation, usually concealed under the symbolic *product* of two *generating operations* or powers thereof, every symmetry operation should be represented by a distinct symbol (in each one of the thirty-two point-groups).

Now, in this scheme, elements of alternating symmetry cannot be dispensed with. Rogers' method gives a truer picture of symmetry relations than that which is based on the use of generating operations, their powers and products. Mathematically, it may not be of any moment to stress the fact that a product of two operations is also an operation by coining a special word to designate the new symmetry operation; such an idealized composite operation (rotatory-reflection or rotatory-inversion) may be considered a very artificial entity being as it is almost always reducible[3] to a product of two simpler operations. Physically, however, the concept introduced by A. F. Rogers has unquestionable significance. A form is defined as the assemblage of all similar (or equivalent) faces; hence, in the general form, any face should be derivable from any other face by means of one symmetry operation only and not in successive steps, inasmuch as, from the physical point of view, there is no justification for privileged symmetry operations (*generating operations*).

Rogers' original application of group theoretical notions to crystal classes throws unexpected light on the nature of crystal symmetry. Not only does it bring out the fact that the polyhedron crystal is carried to self-coincidence by a symmetry operation, it also emphasizes the *equivalence* of the faces (edges and corners, as well) of the general form. The symmetry concept is thereby renovated and enriched.

For the two reasons given in this introduction, the necessity of using alternating symmetry appears undisputable.

TWO DEFINITIONS OF ALTERNATING SYMMETRY

Crystallographers have defined the operation of alternating symmetry in two different ways: (1) as a rotation followed by a reflection in a plane perpendicular to the axis; or (2) as a rotation accompanied by an inversion through a point lying on the axis. These two composite operations may be termed respectively *rotatory-*

[3] Let us recall here the exception of the tetragonal disphenoidal class where the alternating axis is irreducible.

reflection and *rotatory-inversion* or, more concisely, *rotoflection* and *rotoversion*, after Rogers' proposal.

Before going further, the system of notation of symmetry operations and symmetry elements to be used in the discussion must be explained. The symbols are taken from Rogers.[4]

Plane of symmetry: P.

Center of symmetry: C.

Rotation axis: A_p; rotoversion axis: CA_p; rotoflection axis: AP_p; where the *period* p indicates the value of the angle $360°/p$ through which the crystal is rotated about the axis (the possible values of p are 2, 3, 4, and 6). It should be remarked, however, that a 2-fold rotoversion axis is the equivalent of a plane of symmetry for which the symbol P seems more logical and, similarly, that a 2-fold rotoflection axis is equivalent to the center of symmetry which should preferably be designated by C.

As for symmetry operations, small italics are used: p (reflection), c (inversion), a (rotation), ap (rotoflection), and ca (rotoversion). In the last three symbols, a subscript gives (in degrees) the total rotation performed. The identical operation is represented either by 1 or by the power zero of any operation.

There has been no general agreement as to what operation of alternating symmetry should be used in preference to the other. Some authors have adopted rotoflection, others have employed rotoversion. A. F. Rogers uses both; he departs from Hilton in advocating the use of the rotoflection axis AP_6 in the rhombohedral and hexagonal scalenohedral classes of the trigonal subsystem instead of the rotoversion axis CA_3; he represents the symmetry of the trigonal dipyramidal class by CA_6 in contradistinction with Jaeger who uses the rotoflection axis AP_3.

Interest in that much debated question is now being revived by the recent adoption, at Zürich, of a system of international symmetry symbols[5] which is based on the use of one type of alternating axes only, the rotoversion axes. The purpose of the present paper is to show: (1) that the symbols AP_6 and CA_3 on the one hand, CA_6 and AP_3 on the other hand, are strictly equivalent and can be used interchangeably just in the same manner as AP_4 and CA_4; consequently, (2) that the reasons for adopting rotoversion axes rather than rotoflection axes are more formal than fundamental, being simply a matter of convenience and harmony in classification schemes.

[4] Similar symbols for the 3-fold alternating axes had to be added, since Rogers only recognizes alternating axes with an *even* period (4 or 6).

[5] MAUGUIN. *Sur le symbolisme des groupes de répétition* . . . etc. Z. f. Kr., 76: 542–58. 1931.

Alternating axes of crystal symmetry only need be considered here. A complete discussion including non-crystallographic alternating axes has been published by F. Becke.[6]

EQUIVALENCE OF ALTERNATING AXES

Rogers attempts to rule out the 3-fold alternating axes on the principle that the period p of an alternating axis $\mathcal{A}_p$ or $\mathfrak{A}_p$ should always be even. In the discussion of the trigonal dipyramidal class, for instance, he says: "Since there are six distinct operations involved, the axis is clearly 6-fold and not 3-fold. Three powers of $ap_{120°}$ do not form a group; the six powers of $ca_{60°}$ are required. $\mathfrak{A}_6$ and not $\mathcal{A}_3$ must be used to indicate the symmetry in this class."

It is essential to recognize that *the period of an alternating axis does not necessarily indicate the order of the group of symmetry operations represented by that axis*. The two are different: (1) The order n of a point-group indicates the number of operations contained in the group or the number of faces in the general form. (2) The period p of any axis, whether the axis be of the first sort (rotation axis) or of the second sort (alternating axis), refers to the amplitude $360°/p$ of the rotation performed. The group $\mathcal{A}_3$, for instance, is of *order* 6 although the rotation amounts to $360°/3$ in the rotoflection and the *period* of the axis is consequently 3.

When the period of an alternating axis is an even number, such as in the symbols $\mathcal{A}_4$ (or $\mathfrak{A}_4$), $\mathcal{A}_6$, and $\mathfrak{A}_6$, then the *period of the axis* is equal to the *order of the group* represented by the alternating axis. Whether it may not be advantageous to have the order of the group indicated by the period of the axis (when the axis constitutes all the symmetry present) is another question but that this condition should always be fulfilled is by no means required. This point should be kept in mind throughout the following sections.

EQUIVALENCE OF THE 6-FOLD ROTOFLECTION AXIS AND THE 3-FOLD ROTOVERSION AXIS

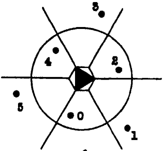
In the rhombohedral class of the trigonal subsystem, Rogers writes the symmetry operations of the point-group as follows:

$$\mathcal{A}_6 = 1,\ ap_{60°},\ a_{120°},\ c,\ a_{240°},\ ap_{300°}.$$

Using the same symbols, we may write:

$$\mathfrak{A}_3 = 1,\ ap_{300°},\ a_{240°},\ c,\ a_{120°},\ ap_{60°}.$$

[6] FRIEDRICH BECKE. *Inversionsachse und Spiegelachse.* N. Jahrb f. Min, B B, 57A: 173–202. 1927 In the preparation of this article, I had overlooked Becke's important paper, which was brought to my attention by Dr. A. F. ROGERS.



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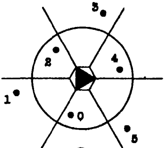

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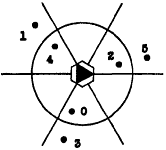

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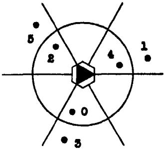

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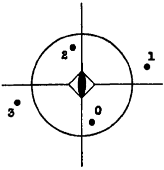
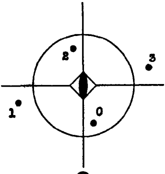


5



6

Fig. 1. General form in the point-group AP_6 (counter-clockwise rotations)
Fig. 2. General form in the point-group CA_3 (counter-clockwise rotations)
Fig. 3. General form in the point-group CA_6 (counter-clockwise rotations)
Fig. 4. General form in the point-group AP_3 (counter-clockwise rotations)
Fig. 5. General form in the point-group AP_4 (counter-clockwise rotations)
Fig. 6. General form in the point-group CA_4 (counter-clockwise rotations)

This will become apparent from inspection of the stereographic projection[7] of the general form obtained in each case (Figs. 1 and 2). The rotations are taken counter-clockwise. The six equivalent faces are numbered from 0 to 5, thus indicating the power of the generating operation which is $ap_{60°}$ in the case of AP_6 and $ca_{120°}$ in the case of CA_3.

The equivalence of the operations in both cases may be shown as follows. Let x represent the 120° rotoversion $ca_{120°}$. The powers of that operation will be:

$$
\begin{aligned}
x^0 &= 1,\\
x &= ca_{120°} = ap_{300°},\\
x^2 &= a_{240°},\\
x^3 &= c,\\
x^4 &= a_{120°},\\
x^5 &= ca_{240°} = ap_{60°}.
\end{aligned}
$$

The two groups AP_6 and CA_3 are thus identical since both contain the same operations. The only difference lies in the sequence of the symmetry operations, but it is well known that the elements of a group may be listed in any order (or rearranged).

Another way of illustrating the identity of the two groups is to remark that the six equivalent faces of Fig. 1 can be derived by means of a CA_3 and those of Fig. 2 by means of an AP_6 provided simply that the convention of signs be reversed (clockwise instead of counter-clockwise rotations).

EQUIVALENCE OF THE 6-FOLD ROTOVERSION AXIS AND THE 3-FOLD ROTOFLECTION AXIS

For the trigonal dipyramidal class of the hexagonal system, the identity of the two groups CA_6 and AP_3 can be proved in like manner. The 1st power of $ap_{120°}$ is equal to the 5th power of $ca_{60°}$; the 2nd of $ap_{120°}$ to the 4th of $ca_{60°}$, etc.

The six operations may be written indifferently:

$$CA_6 = 1,\ ca_{60°},\ a_{120°},\ p,\ a_{240°},\ ca_{300°},$$

or

$$AP_3 = 1,\ ca_{300°},\ a_{240°},\ p,\ a_{120°},\ ca_{60°}.$$

The general form is shown in stereographic projection (Figs. 3 and 4).

[7] The face-poles are projected on the equatorial plane; the projecting point is the South pole for all faces.

The same remark holds true with regard to the order in which the six faces are derived and the convention of sign for the rotations.

EQUIVALENCE OF THE 4-FOLD ROTOFLECTION AND ROTOVERSION AXES

For the sake of completeness and in order to stress the perfect analogy of the three cases, the identity of AP_4 and CA_4 (tetragonal disphenoidal class of the tetragonal system) is also shown here by means of the usual projections (Figs. 5 and 6).

The two groups may be written:

$$\mathit{AP}_4 = 1,\ ap_{90°},\ a_{180°},\ ap_{270°},$$

and

$$\mathit{CA}_4 = 1,\ ap_{270°},\ a_{180°},\ ap_{90°}.$$

Here again, the second group contains the rearranged elements of the first group. The equivalence of the 4-fold alternating axes was brought out by A. F. Rogers in his article.

It has been shown that an alternating axis of period 3 can be used to represent a point-group of order 6. This result leaves intact the method proposed by Rogers for the derivation of faces in the general form. Whether rotoflection alone or rotoversion alone be used, it is possible to derive each and every face of the general form $\{hkl\}$ directly from any arbitrarily selected face.

The symmetry operations of the rhombohedral class (trigonal subsystem), the tetragonal disphenoidal class (tetragonal system), and the trigonal dipyramidal class (hexagonal system) may be listed in either one of the two following ways:

$$\begin{aligned} \mathit{CA}_3 &= 1,\ ca_{120°},\ a_{240°},\ c,\ a_{120°},\ ca_{240°}, \\ \mathit{CA}_4 &= 1,\ ca_{90°},\ a_{180°},\ ca_{270°}, \\ \mathit{CA}_6 &= 1,\ ca_{60°},\ a_{120°},\ p,\ a_{240°},\ ca_{300°}; \end{aligned} \tag{I}$$

or

$$\begin{aligned} \mathit{AP}_6 &= 1,\ ap_{60°},\ a_{120°},\ c,\ a_{240°},\ ap_{300°}, \\ \mathit{AP}_4 &= 1,\ ap_{90°},\ a_{180°},\ ap_{270°}, \\ \mathit{AP}_3 &= 1,\ ap_{120°},\ a_{240°},\ p,\ a_{120°},\ ap_{240°}. \end{aligned} \tag{II}$$

The equivalence of the new symbols with those employed by A. F. Rogers is given below:

$$\begin{aligned} ca_{120°} &= ap_{300°}, & ca_{240°} &= ap_{60°}, \\ ca_{90°} &= ap_{270°}, & ca_{270°} &= ap_{90°}, \\ ap_{120°} &= ca_{300°}, & ap_{240°} &= ca_{60°}. \end{aligned}$$

CHOICE OF THE ALTERNATING AXES

There are two main possibilities: (1) Discard the 3-fold alternating axes and use Æ_4 (or Ɑ_4), Æ_6, and Ɑ_6. This is the course followed by Rogers. (2) Use one kind of alternating axes only, either rotoflection axes (Æ_6, Æ_4, Æ_3) or rotoversion axes (Ɑ_3, Ɑ_4, Ɑ_6). The exclusive use of rotoversion axes was the solution adopted by international agreement at the Zürich meeting.

The merits of the alternating axes of even period will be discussed first.

The advantage of this solution can be seen by glancing over the list of the symmetry symbols given by Rogers for the 32 crystal classes[8]: the order of the point-group (hence, the number of faces in the general form) can be read directly from the symmetry symbol or can be deduced from it by a simple count:

(a) When there is only one element of symmetry present, its order is the order of the group. It is equal to 2 in the case of a plane of symmetry (P), a center (C), or a 2-fold axis of symmetry (A_2). In general, the subscript of the axis symbol gives its order (A_2, A_3, A_4, Æ_4, Æ_6, Ɑ_6).

(b) When there are several symmetry elements, the order of the group is given by 1 (identical operation) plus the order of each element each decreased by one. *Example:*

$$3A_4.4A_3.6A_2,\ \text{order} = 1+3\times3+2\times4+1\times6=24.$$

Symmetry elements placed between parentheses in Rogers' symbols must be ignored in the count since they are implicitly included in the other symmetry elements listed.

(c) When two (or more) symmetry elements have operations in common, brackets are used. The total obtained by the above rule should be decreased accordingly. Minus one for one element between brackets.

Example:

$$A_4[\text{Æ}_4].P.C,\ \text{order} = 1+3\times2+1\times2-1=8.$$

Minus four for two elements between brackets.

Example:

$$A_6[\text{Æ}_6][\text{Ɑ}_6](P).(C),\ \text{order} = 1+5\times3-4=12.$$

(d) In two isometric classes (diploidal and hexoctahedral) where 4 Æ_6 are found, it should also be realized that the center is included

[8] Op. cit., p. 200.

in each one of these, so that the order found must be corrected accordingly (minus 3).

Example:

$$4\ AP_6.3A_2.3P.(C),\ \text{order} = 1+5\times 4+3+3-3 = 24.$$

The value of using one kind of alternating axes is of course simplicity; it is better to resort to one type of alternating symmetry than to two.

There is no particular advantage in choosing rotoflection only. The selection of rotoversion axes, on the contrary, lends itself to a better division of the 32 classes into systems. This fact, which had been pointed out by Hilton,[9] probably accounts for the adoption of rotoversion axes by the Zürich convention.

Let us observe that the rhombohedral and hexagonal scalenohedral classes, both of which belong to the trigonal subsystem, have a $\mathcal{A}_3$ in their respective symmetry symbols. Similarly, the trigonal dipyramidal and ditrigonal dipyramidal classes of the hexagonal system include the symmetry element $\mathcal{A}_6$. A further advantage is seen in the isometric system where all five classes now have four 3-fold axes (either rotation axes or rotoversion axes) parallel to the cube diagonals.

It will be realized that the reasons for selecting rotoversion axes are of no fundamental importance, the object being merely to attain a set of convenient symbols fitting in the frame of the traditional classification into systems. It must be added that this aim, modest as it was, has been fully reached.

THE INTERNATIONAL SYMMETRY SYMBOLS

The international system of symmetry notation agreed upon at the Zürich meeting, August 28–31, 1930, is due to the collaboration of C. Hermann, Ch. Mauguin, J. D. Bernal, P. P. Ewald, and others. It may be said to be epoch making in that, through its comprehensiveness, it bridges the gap which so far has divided geometrical and structural crystallographers. It remarkably brings out the relationships between the various groups of symmetry operations in the 3-dimensional space: the 32 point-groups or groups without any translation (one point remaining fixed), the 75 chain-groups or groups with one independent translation only, the 80 net-groups or groups

[9] HAROLD HILTON. *Note on the thirty-two classes of symmetry.* Min. Mag., 14: 261–3. 1906.

with two translations, and the 230 space-groups or groups with three translations.

The 230 space-groups and the 32 point-groups obviously are the most important from the practical viewpoint. The new symbols recognize the fact that each one of the 230 space-groups is isomorphous with one of the 32 point-groups: slight modification of a space-group symbol immediately leads to the symbol of the isomorphous point-group.

It appears that, from now on, the Zürich symbols will be used both in geometrical and in structural crystallography. It seems advisable

TABLE 1.—PRINCIPLE OF THE INTERNATIONAL SYMMETRY SYMBOLS

Elements of Symmetry	Symbols
Rotation axes.	1, 2, 3, 4, 6.
Remark: Any straight line may be considered a 1-fold rotation axis Class 1 is the pedial class	
Rotoversion axes:	
With an odd period	$\bar{1}$, $\bar{3}$.
Remark: These always contain the center of symmetry, the axis is at the same time a rotation and a rotoversion axis of the same period. Class $\bar{1}$ is the pinakoidal class.	
With an even period.	
Devoid of center of symmetry	$\bar{2}$, $\bar{4}$, $\bar{6}$.
Remarks: (a) a $\overline{2n}$-fold rotoversion axis is at the same time a n-fold rotation axis.	
(b) $\bar{2}$ is a plane of symmetry m	$\bar{2} = m$.
(c) $\bar{4}$ is irreducible	$\bar{4}$.
(d) $\bar{6}$ includes a 3-fold rotation axis and a plane of symmetry perpendicular to it	$\bar{6} = 3/m$.
Centro-symmetric	$2/m$, $4/m$, $6/m$.
Remark: These axes are at the same time rotation and rotoversion axes of the same period; they always include a plane of symmetry normal to the axis.	

to introduce their use in elementary courses in crystallography. The present discussion of alternating axes may serve as an introduction to the study of the new symbols the simplicity of which is mostly due to the use of the sole rotoversion axes.

A brief summary of the notation will be given here insofar as it deals with the 32 crystal classes (see Table I). The new symmetry symbols are listed in Table II. Other symbols are also given for comparison: Schoenflies, A. F. Rogers, together with the nomenclatures of Groth and Dana.

In the *complete* form of the Mauguin point-group symbols, there are as many terms as there are kinds of symmetry axes in the group. In an orthorhombic symmetry symbol, the three terms refer to the a-axis, the b-axis, and the c-axis respectively (right-handed system

TABLE 2.—COMPARISON OF VARIOUS SYSTEMS OF POINT-GROUP SYMMETRY SYMBOLS

Systems	Schoen-flies	Mauguin (International) Complete	Abridged	Preferred	A. F. Rogers	Dana	Groth (modified)
Triclinic	C_1	1	1	1		Asymmetric	Pedial
	S_2	$\bar{1}$	$\bar{1}$	$\bar{1}$	C	Normal	Pinakoidal
Monoclinic	C_1^h	m	m	m	P	Clinohedral	Domatic
	C_2	2	2	2	A_2	Hemimorphic	Sphenoidal
	C_2^h	$2/m$	$2/m$	$2/m$	$A_2\ P.\ C$	Normal	Prismatic
Ortho-rhombic	C_{2v}	$2\ m\ m$	$2\ m$	$m\ m$	$A_2.\ 2P$	Hemimorphic	Rhombic pyramidal
	V	$2\ 2\ 2$	$2\ 2$	$2\ 2\ 2$	$3A_2$	Sphenoidal	Rhombic disphenoidal
	V^h	$2/m\ 2/m\ 2/m$	$2/m\ m$	$m\ m\ m$	$3A_2.\ 3P\ C$	Normal	Rhombic dipyramidal
Tetragonal	S_4	$\bar{4}$	$\bar{4}$	$\bar{4}$	AP_4	Tetartohedral	Tetragonal disphenoidal
	V_d	$\bar{4}\ 2\ m$	$\bar{4}\ 2$	$\bar{4}\ 2\ m$	$AP_4.\ 2A_2.\ 2P$	Sphenoidal	Tetragonal scalenohedral
	C_4	4	4	4	A_4	Pyramidal hemimorphic	Tetragonal pyramidal
	C_4^h	$4/m$	$4/m$	$4/m$	$A_4[AP_4].\ P.\ C$	Tripyramidal	Tetragonal dipyramidal
	C_4^v	$4\ m\ m$	$4\ m$	$4\ m\ m$	$A_4.\ 4P$	Hemimorphic	Ditetragonal pyramidal
	D_4	$4\ 2\ 2$	$4\ 2$	$4\ 2$	$A_4\ 4A_2$	Trapezohedral	Tetragonal trapezohedral
	D_4^h	$4/m\ 2/m\ 2/m$	$4/m\ m$	$4/m\ m\ m$	$A_4[AP_4]\ 4A_2.\ 5P\ C$	Normal	Ditetragonal dipyramidal
	C_3	3	3	3	A_3	Trigonal tetartohedral hemimorphic	Trigonal pyramidal
Trigonal	C_3^i	$\bar{3}$	$\bar{3}$	$\bar{3}$	$AP_6.\ (C)$	Trirhombohedral	Rhombohedral
	C_3^v	$3\ m$	$3\ m$	$3\ m$	$A_3.\ 3P$	Rhombohedral hemimorphic	Ditrigonal pyramidal
	D_3	$3\ 2$	$3\ 2$	$3\ 2$	$A_3.\ 3A_2$	Trapezohedral	Trigonal trapezohedral
	D_3^d	$\bar{3}\ 2/m$	$\bar{3}\ m$	$\bar{3}\ m$	$AP_6.\ 3A_2.\ 3P.\ (C)$	Rhombohedral	Hexagonal scalenohedral
Hexagonal	C_3^h	$\bar{6}$	$\bar{6}$	$\bar{6}$	$CA_6(P)$	Trigonal tetartohedral	Trigonal dipyramidal
	D_3^h	$\bar{6}\ 2\ m$	$\bar{6}\ 2$	$\bar{6}\ 2\ m$	$CA_6(P)\ 3A_2\ 3P$	Trigonal	Ditrigonal dipyramidal
	C_6	6	6	6	A_6	Pyramidal hemimorphic	Hexagonal pyramidal
	C_6^h	$6/m$	$6/m$	$6/m$	$A_6[AP_6][CA_6](P)\ (C)$	Tripyramidal	Hexagonal dipyramidal
	C_6^v	$6\ m\ m$	$6\ m$	$6\ m\ m$	$A_6.\ 6P$	Hemimorphic	Dihexagonal pyramidal
	D_6	$6\ 2\ 2$	$6\ 2$	$6\ 2$	$A_6.\ 6A_2$	Trapezohedral	Hexagonal trapezohedral
	D_6^h	$6/m\ 6/m\ 6/m$	$6/m\ m$	$6/m\ m\ m$	$A_6[AP_6][CA_6](P)\ 6A_2.\ 6P.\ (C)$	Normal	Dihexagonal dipyramidal
Isometric	T	$2\ 3$	$2\ 3$	$2\ 3$	$4A_3.\ 3A_2$	Tetartohedral	Tetartoidal
	T^h	$2/m\ \bar{3}$	$2/m\ 3$	$m\ 3$	$4AP_6.\ 3A_2\ 3P\ (C)$	Pyritohedral	Diploidal
	T^d	$\bar{4}\ 3\ m$	$\bar{4}\ 3$	$\bar{4}\ 3\ m$	$3AP_4.\ 4A_3.\ 6P$	Tetrahedral	Hextetrahedral
	O	$4\ 3\ 2$	$4\ 3$	$4\ 3$	$3A_4.\ 4A_3.\ 6A_2$	Plagiohedral	Gyroidal
	O^h	$4/m\ \bar{3}\ 2/m$	$4/m\ 3$	$m\ 3\ m$	$3A_4[3AP_4].\ 4AP_6.\ 6A_2.\ 9P.\ (C)$	Normal	Hexoctahedral

used by crystallographers). In the dimetric systems (trigonal, tetragonal, hexagonal), the first term refers to the vertical axis (c-axis), the last (one or two) to the horizontal axes of two-fold symmetry. In the isometric system, the first term refers to the axes parallel to the edges of the cube; the second term, to the axes parallel to the body-diagonals of the cube; the third term, to the axes parallel to the face-diagonals of the cube. All isometric point-group symbols have the figure 3 as their second term.

Abridged symbols are obtained by omitting the third term in all cases and writing m instead of $2/m$ for the second term of the symbol in the case of a centro-symmetric point-group.

The *preferred symbols* retain *all symmetry planes* in view of generalizations to be made in the space-group symmetry symbols (see Mauguin, *loc. cit.*).

It will be noticed that the Greek letter μ of the former Hermann's symbols is now replaced by m, the initial of mirror, to designate the plane of symmetry.

The new international notation aims at representing the groups by short, self-explanatory symbols listing a minimum of symmetry elements, sufficient to characterize all the symmetry present.

THE STATUS OF THE CENTER OF SYMMETRY

In connection with the preceding discussion of alternating axes, it is thought appropriate to consider briefly the so-called validity of the center as a true element of symmetry.

First of all, it should be realized that there is no point of fundamental importance to be settled in this "problem" and that all discussions on the subject, due to the very nature of the case, are apt to be vain and sterile. The following remarks can be made.

There is no more reason to discard the center of symmetry and replace it by a 2-fold rotoflection axis than there is to abolish the plane of symmetry and substitute a 2-fold rotoversion axis for it.

In the first instance, the bare fact is this: in a centro-symmetric crystal, to any face arbitrarily selected at one end of the crystal, there corresponds a parallel face, similar (equivalent) to the first, at the opposite end of the crystal. It is possible to derive the second face from the first by means of a symmetry operation. Whether this operation should be characterized as an inversion through the center or a 180° rotoflection about a rotoflection axis (which cannot be defined in direction) is only a question of words; the fundamental observation will not be changed by either interpretation.

Likewise, in the case of a plane of symmetry, the fact is that to every face on one side of a plane there corresponds a similar face, the *mirror-image* of the first, on the other side of the plane. Why should one consider the operation involved as a 180° rotoversion about a rotoversion axis (normal to the plane of symmetry) when this new picture has no advantage over the age-old and simple concept of the "reflection"? The only essential point to be stressed is the existence of a symmetry operation by means of which a face and its mirror-image can be derived from each other. It must be admitted that there is no need to introduce a composite operation when there is already a simple operation providing for direct derivation.

The status of the center of symmetry and that of the plane of symmetry are thus intimately linked. The use of the composite operation in either case masks the facts more than it brings them out.

Both center and plane of symmetry should therefore be retained.

ACKNOWLEDGMENTS

I wish to thank my former professor Dr. Austin F. Rogers of Stanford University for a critical reading of this manuscript and for his continued interest in my work. Valuable suggestions were also obtained from Dr. George Tunell of the Geophysical Laboratory, which are gratefully acknowledged.

BOTANY.—*The genus* Chionopappus *of Bentham* (*Asteraceae*).[1]

S. F. BLAKE, Bureau of Plant Industry.

In 1873 George Bentham described the new genus *Chionopappus* of the tribe "Mutisiaceae," subtribe Onoserideae, in the family Compositae. It was based on a single species, to which no name was assigned, which was said to be a native of northern Peru. Nothing has been added to our knowledge of the genus, and after the lapse of more than sixty years it remains a "genus without a species." Baillon (1882) placed it in the Mutisieae, and Hoffmann (1893) in the Mutisieae-Gochnatinae, both accounts being based entirely on Bentham's original description. Bentham remarked that the genus was remarkable in its tribe for its opposite leaves and paleaceous receptacle, and abnormal in its ligulate not bilabiate ray corollas, but that in its style and its rays, 4-merous according to their venation, it agreed with no other tribe.

[1] Received July 18, 1935.

During the last twenty years there have come to hand from the Department of Lima, Peru, several collections of a Liabum-like Composite agreeing closely with Bentham's description in all major features—foliage, heads, involucre, paleaceous as well as pilose receptacle, corollas, and pappus—but differing in at least two points of structure that are of great importance in the classification of Compositae. Bentham described the style of the hermaphrodite flowers as undivided or barely emarginately 2-lobed, and the anthers as sagittate at base and with long, very slenderly caudate-acuminate auricles. In the recently collected plants the style branches are rather long, linear, obtusish, and hispidulous outside with the hairs continuing far below the fork, almost in the manner of *Vernonia*, and the anthers, while deeply sagittate, are polliniferous almost to the tip of the lance-linear auricles, with only a very short (about 0.1–0.2 mm. long) obtuse cellular sterile apiculation, and so not truly caudate. Through the kindness of Sir Arthur W. Hill, I have been permitted to borrow Bentham's type sheet[2] from the Kew Herbarium and resolve the riddle.

The type sheet bears three pieces of stem a few inches long and a pocket containing flowers, achenes, pappus, and a few phyllaries derived from one of the heads, as well as a head in bud. The specimens are nearly leafless, bearing altogether only a couple of pairs of upper leaves and a few bracts. They are accompanied by a printed label: "Lima et Peruvia septentrionalis. H. Cuming, 1831," with the written number 996. In publishing the genus, Bentham quoted only the second part of the habitat as given, whereas recent collections are all from the region of Lima, indicating that Cuming's plant probably came from the same region, in central western Peru. The name *Chionopappus* does not appear on the sheet. In addition to some notations by Bentham on the details of structure, the sheet bears the name "*Liabum*? n. sp." and "Cf. Erato"[3] in Bentham's hand. The specimens are clearly identical specifically with the later collections by Rose, Macbride, and Pennell. Examination shows that most if not all the detached styles preserved in the pocket have had their tips chewed off by insects, thus presenting the appearance of being undivided recorded by Bentham. Examination of one of the heads on the sheet with a lens, however, reveals uninjured forked styles

[2] The sheet sent me is one from Bentham's own herbarium. Mr. John S. L. Gilmore writes that there is another sheet of the same collection, also with very scanty material, in the Hooker Herbarium.

[3] *Erato* is now treated as a section of *Liabum*.

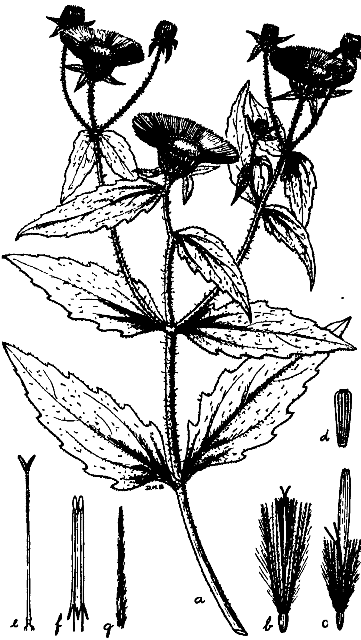


Fig. 1.—*Chionopappus benthamii* Blake.—*a*, plant, ×1; *b*, disk flower, ×3½; *c*, ray flower, ×2½; *d*, achene with pappus fallen, ×8; *e*, style of disk flower, ×4½; *f*, two stamens, ×10; *g*, receptacular pale, ×4.—All drawn from *Macbride & Featherstone* 162, in the Field Museum, except fig. *d*, which is drawn from the type, *Cuming* 996, in the Kew Herbarium.

protruding from some of the anther-tubes. The anthers are somewhat shriveled and appear to have more slender auricles than the recent specimens, but are not really different in structure. In no case do they have the stiff texture so characteristic of the terminal appendages and the anther tails in both Mutisieae and Cynareae. Bentham's description of the heads as nodding was obviously based on only one of the four heads on the type sheet, and since the numerous heads on the recent specimens are all erect, the appearance of this head must be attributed to some peculiarity of preparation. Finally, Bentham's emphasis on the 4-merous nature of the ray corollas, as deduced from their venation—the nerves were described as 4—as an indication that the genus could go in no other tribe is a curious slip, for the reason that the alternation of nerves and teeth which is fundamental in the corollas of Compositae makes it necessary for a normal 3-merous ray to have four nerves[4] (when supplementary ones are not present), and for a 4-merous ray to have five.

Since the principal characters relied on by Bentham to place the genus in the Mutisieae are based on wrong interpretation of the material, there arises a question as to its proper position. Its combination of characters rules out all tribes except the Senecioneae (subtribe Liabinae), and—doubtfully, from the fact that the anthers are not truly caudate—the Inuleae (subtribe Buphthalminae) and the Mutisieae (subtribe Gochnatinae of Hoffmann). Comparison with these groups shows that the natural position of *Chionopappus* is definitely in the subtribe Liabinae next to *Liabum*, from which genus, taken in its broad sense, it differs primarily only in its truly paleaceous receptacle[5] and its 1-seriate pappus of relatively few long-plumose awns united at base and deciduous in a ring. In all other features—habit, opposite leaves which are tomentose beneath, involucre, several-seriate narrow rays, disk corollas, achenes, styles, and anthers—it can be closely matched in the *Liabum* group. The revised generic description and the specific description follow.

[4] One running toward each sinus, one on each side of lamina about midway between the sinus-nerve and the margin.

[5] Bentham and Hooker described the receptacle in *Liabum* as naked, alveolate, or fimbrillate. Rydberg (N Am Fl. 34: 289. 1927), who splits the North American and West Indian representatives of *Liabum* into 5 genera, describes it in his restricted genus *Liabum* (including the *L. umbellatum* and *L. igniarium* groups) as "bristly-fimbriate to chaffy with subulate paleae." The receptacle in these species does not bear true paleae but is deeply alveolate, with the margins of the alveolae prolonged into stiff mostly subulate awn-like structures about the length of the achenes and surrounding them. *Chionopappus*, in contrast, has true paleae in the shape of slender linear-subulate chaff, one to each flower. That this difference is not sufficient to exclude *Chionopappus* from the *Liabum* alliance is indicated by a more or less similar variation in several of the tribes of Compositae.

CHIONOPAPPUS Benth. in Benth. & Hook. Gen. Pl. 2: 485. 1873 (without species name)

Suffrutescent, branching, pubescent; leaves opposite, ovate to oblong-ovate, short-petioled, triplinerved, coarsely serrate, green and scabrous-pubescent above, white-tomentose beneath; heads medium-sized, heterogamous, radiate, short-peduncled, mostly ternate at tips of stem and branches, the rays yellow, the disk purple; involucre campanulate or hemispheric-campanulate, usually with a few leafy bracts at base, the proper phyllaries strongly graduate, about 5–7-seriate, ovate to (inner) lance-linear, acuminate, erect, subchartaceous, the outer with short and narrow obscurely herbaceous tip; receptacle broad, flat, densely long-pilose, paleaceous throughout with linear-subulate firm pales about equaling the pappus; rays very numerous, 2–3-seriate, pistillate, fertile, yellow, the lamina spreading, linear, usually 3-denticulate, 4-nerved; disk flowers very numerous, hermaphrodite, fertile, their corollas regular, tubular, slender-funnelform, deeply 5-fid, the lobes much longer than the throat; anthers deeply sagittate at base, with obscurely appendaged auricles, and with oblong-ovate apical appendages; style hispid far below the fork, the branches linear, obtuse, at length spreading, hispidulous outside, stigmatiferous over whole inner surface, unappendaged; achenes oblong or narrowly obovoid, somewhat compressed, 8–10-ribbed, small, glabrous; pappus of 10–15 1-seriate very slender long-plumose white awns, united at base and deciduous in a ring. Type species, *Chionopappus benthamii.*

Chionopappus benthamii Blake, sp. nov.

Suffrutescens ca. 1 m. altus opposite ramosus; caulis subteres fragilis albidus v. brunneus subdense hirsuto-pilosus pilis patentibus multiloculatis basi subtuberculatis et parum puberulus, aetate glabratus; internodia 2.5–6 cm. longa; petioli 1–2 mm. longi vix marginati basi connati, basibus demum incrassatis et breviter vaginiformibus; laminae ovatae v. oblongo-ovatae 3.8–6 cm. longae 1.5–2.8 cm. latae acutae calloso-mucronulatae basi cuneatae v. rotundato-cuneatae in petiolum breviter decurrentes prope basin triplinerviae subtenues grosse et irregulariter serratae dentibus majoribus ca. 6–8-jugis calloso-mucronulatis supra virides dense scabro-hispidae et hispidulae pilorum basibus tuberculatis persistentibus aetate rugoso-bullatae subtus venis majoribus breviter hirsutis exceptis dense et persistenter albo-arachnoideo-tomentosae; capitula apice caulis et ramorum saepe ternata erecta ca. 2–3.3 cm. lata basi bracteis 2–4 foliis similibus sed multo minoribus lanceolatis patentibus v. reflexis suffulta, pedunculis sicut caule pubescentibus 0.7–4 cm. longis; discus (siccitate) 1–1.2 cm. altus 1–2 cm. diam.; involucri 9–11 mm. alti juventate paullum arachnoideo-tomentosi phyllaria flavido-albida ad apicem saepe purpurascentia inconspicue 1–3-nervia dense sordido-puberula et versus apicem saepius patenti-hirsuta, exteriora acuminata apice interdum sublaxa breviter subherbacea, interiora linearia v. lineari-lanceolata longe acuminata exterioribus multo angustiora; radii ca. 100 aurei apice interdum purpurascentes ad apicem tubi et basin laminae sparse puberuli ceterum glabri, tubo 5 mm. longo, lamina ca. 11 mm. longa 1 mm. lata; corollae disci valde numerosae glabrae infra pallidae supra medium saturate purpureae ca. 8 mm. longae (tubo ca. 3.5 mm., faucibus 1.5–1.8 mm., dentibus anguste triangularibus acuminatis apice intus paullum incrassatis 2.5–

8 mm. longis); paleae receptaculi anguste lineari-subulatae firmae albidae longe ciliatae et pilosae ca. 8 mm. longae; achenia albida 2 mm. longa 0.5 mm. lata; pappus niveus 7–8 mm. longus, aristis angustissimis complanatis ad apicem multo brevius plumosis.

PERU: "Lima et Peruvia septentrionalis," 1831, *Cuming* 996 (type, Herb. Kew; photog., U. S. Nat. Herb.); vicinity of Matucana, 9 July 1914, *Dr. & Mrs. J. N. Rose* 18663 (U. S. Nat. Herb.); rock crevices and in loose rock, Matucana, 12 April–3 May 1922, *Macbride & Featherstone* 162 (Field Mus., U. S. Nat. Herb.); open rocky slopes, along Rio Chillón, near Viscas, Dept. Lima, alt. 1800–2000 m., 10–15 June 1925, *Pennell* 14480 (U. S. Nat. Herb.).

Macbride and Featherstone describe their plant as woody at base, very brittle, 3 ft. high; Pennell describes his as a shrub, with "light cadmium" rays and "bordeaux" disk.

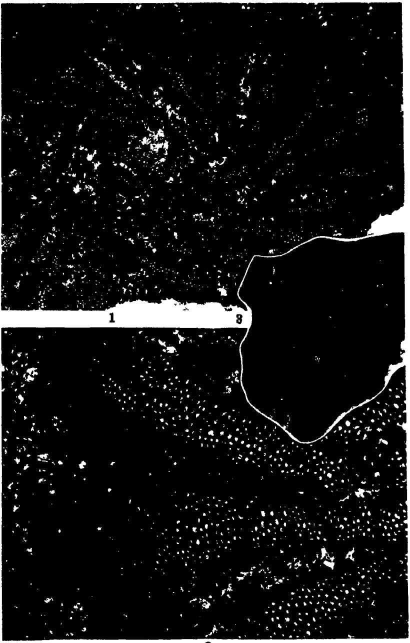
PALEOBOTANY.—*An occurrence of the genus* Cladoxylon *Unger, in North America.*[1] CHARLES B. READ, U. S. Geological Survey. (Communicated by ROLAND W. BROWN.)

In 1882 J. W. Dawson published a brief account of a specimen of *Cladoxylon mirabile* Unger from the Styliola limestone (Genundewa limestone member of Genesee shale) of western New York.[2] Although no figures are given, it is clear from the text that the plant was of the *Cladoxylon* type and distinct from *Asteropteris noveboracensis*, with which Dawson was well acquainted. It is unfortunate that in most of the more recent accounts of *Cladoxylon* this single American record had been overlooked or else considered too questionable to mention.

In the collection of thin sections of fossil plants prepared under the direction of the late Dr. F. H. Knowlton and now in the hands of the U. S. Geological Survey there is a single transverse section labeled *Cladoxylon mirabile* Unger and recorded from the "Genesee shale, Styliola layer (Genundewa limestone), Canandaigua, New York," and presented to Knowlton by John M. Clarke. Since Clarke was the collector of Dawson's material, it is probable that this section is from the block recorded in the Canadian report. At any rate the specimen is material evidence of the occurrence of *Cladoxylon* in America and therefore deserves to be brought to the attention of paleobotanists. The writer prefers to record this form as new rather than to place it in a doubtful synonomy with the poorly figured *C. mirabile* or other European species.

[1] Published with the permission of the Director of the U. S. Geological Survey. Received July 8, 1935.

[2] DAWSON, J. W. *The fossil plants of the Erian (Devonian) and Upper Silurian formations of Canada.* Canada Geol. Survey Pt. 2: 126. 1882.



2

Fig. 1.—Photograph of transverse section of *Cladoxylon dawsoni*, n. sp., showing the radiating bands of xylem. ×18. Fig. 2.—Same specimen showing the details of two of the plates of xylem. Note the "loops" near the outer edge indicating the position of protoxylem. ×42. Fig. 3.—Thin section of *C. dawsoni*, n. sp., showing the general aspect of the plant. ×6½.

Cladoxylon Unger

Unger, Franz, in Richter, Reinhard, and Unger, Franz. *Beitrag zur Paläontologie des Thüringer Waldes.* K. Akad. Wiss. Wien, Math.-nat. Klasse, Denkschr. Bd. 11: 179. 1856.

Solms-Laubach, H. Graf zu. *Ueber die seinerzeit von Unger beschriebenen strukturbietenden Pflanzenreste des Unterculm von Saalfeld in Thüringen.* K. preuss. geol. Landesanstalt, pp. 52–56. 1896.

Cladoxylon dawsoni, n. sp.

Cladoxylon mirabile Unger. Dawson, J. W. *The fossil plants of the Erian (Devonian) and Upper Silurian formations of Canada.* Canada Geol. Survey. Pt. 2: 126. 1882.

A photograph at low magnification of the thin section of *Cladoxylon dawsoni* from New York is shown in Figure 3. It is clear from this that the stem, which is very well preserved, consists of a central area of steles and a rather thick sheath of cortex. These steles, which are several, are radiating plates or flattened strands of xylem presumably surrounded by phloem and pericycle, although these latter tissues are not preserved. As is indicated more clearly by Figure 1, some of the steles are highly curved and form narrow U- or V-shaped masses, the extremities of which abut on the periphery of the stelar area.

The protoxylem groups occupy immersed positions in the distal or peripheral portions of the steles and in the instance of the strongly curved and forked strands these groups may be several. The position of the protoxylem is marked by a cavity or loop, the delicate tissue usually being disorganized. These loops are well shown in both Figures 1 and 2.

As regards the mass of the xylem, it is for the most part primary. A limited amount of secondary growth occurs on the periphery of a few of the steles but is of very limited extent Since longitudinal sections are not available it has been impossible to make a detailed study of the pitting. However, at a few points in the transverse section contortion of the tissue is sufficient to expose short portions of the tracheids obliquely, so that it can be stated with confidence that the pitting is scalariform.

As has been previously indicated, the zone referable to the phloem is very poorly preserved, only occasional vestiges of tissue remaining. In general this area conforms in its outlines to the contour of the xylem, and the tissue must have occupied the deep embayments between the xylem plates as well as a limited zone around the periphery. Very few observations have been made, in fact, on the phloem of any species of *Cladoxylon*, owing to the almost invariably poor preservation.

The cortex consists of a broad zone of thin-walled, large-lumened tissue, apparently of parenchymatous nature. Locally the cell walls may appear thickened, but this is due to maceration and swelling. In the type specimen of *Cladoxylon mirabile* from Saalfeld in Thuringia, Solms-Laubach[3] states the cell walls of the cortical tissue are thickened and somewhat fibrous. However, it is probable that this is due to the preservation, for Solms-Laubach mentions in the same account that the Saalfeld material characteristically shows a swelling of the cell walls with resulting diminution in size of the lumens.

[3] Solms-Laubach, H. Graf zu *Ueber die Seinerzeit von Unger beschriebenen strukturbietenden Pflanzenreste des Unterculm von Saalfeld in Thüringen.* K. preuss. geol. Landesanstalt, p. 53. 1896.

The peripheral edges of several of the strands are marked by the presence of small, annular masses of xylem apparently departing in the manner of leaf traces Here again the preservation is poor, so that it is impossible to describe these structures in detail At several points in the cortex there are similar concentric areas of disorganised tissues which suggest leaf traces More material is necessary, however, to determine the details of these

An examination of the available figures of the several species of *Cladoxylon* suggests a comparison with *Cladoxylon* (*Arctopodium*) *radiatum* Unger The published figures are not sufficiently definite to tie the two together, however Further, Dr Paul Bertrand, who has made a detailed study of the Saalfeld Cladoxylons, has examined the specimen here under discussion and is inclined to regard it as new In consequence the name *Cladoxylon dawsoni* has been given this specimen in honor of the eminent Canadian paleontologist who first described it

The interest of this fossil lies at present not so much in its structure, which naturally cannot be completely worked out with the scanty material at hand, but rather in its occurrence in the New York Devonian in the same beds with several species of *Callixylon* that Arnold[4] has described It is regrettable that this record of Dawson's has been overlooked for so long

As regards affinities, it will be recalled that specimens of the genus *Cladoxylon* have excited speculation as to their phyletic position ever since their discovery by Unger in Thuringia Ascribed variously to the Pteridophyta and the Cycadofilicales, published investigations have not yet definitely proven their relationships The discovery by Kräusel and Weyland of the leaves of *Cladoxylon scoparium* in strata of Middle Devonian age near Elberfeld Germany, has, however, cleared up certain points In this plant, identified by its stem structure, the leaves are spirally arranged and are small, petiolate, divided, and forked organs, the venation of which has not been determined In addition to these sterile leaves there are fertile leaves—sporophylls—fan-shaped and lobed and with the distal edges hollowed to form numerous cup-shaped depressions which suggest marginal sori Associated with these are the remains of numerous sporangia and spores

Bertrand[6] has discussed in several short papers the possible rela-

[4] ARNOLD, C A *The genus Callixylon from the Upper Devonian of central and western New York* Michigan Acad. Sci Papers 11 1–50, pls 1 19, 1 text fig 1929 (1930)

[5] KRÄUSEL, R, and WEYLAND, H *Beiträge zur Kenntnis der Devonflora*, Pt. 1 Senckenberg Wiss Mitt. Bd 5 (Heft 5–6) 154–184 1923 *Beiträge zur Kenntnis der Devonflora*, Pt 2 Senckenberg naturf Gesell Bd 40 (Heft 2) 113–155 1926

[6] BERTRAND, PAUL *Sur les stipes de Clepsydropsis* Compt Rend Acad Sci Paris 147 945–947 1908 *Observations sur les Cladoxylées* Assoc franç Av Sci, 40th Sess., pp 506–509 1911 *État actuel de nos connaissances sur les genres 'Cladoxylon' et "Steloxylon* Assoc franç Av Sci, 43d Sess, pp 446–448 1914 *Observations sur les Cladoxylées de Saalfeld* Compt Rend Acad Sci Paris 195 1303 1932 *Valeur morphologique du rachis primaire des Cladoxylées et des Zygopteridées* Compt Rend Acad Sci Paris 196 364 1933 *Specifications des Cladoxylon et des Clepsydropsis de Saalfeld* Compt Rend Acad Sci Paris 196 365 1933

tionship of *Clepsydropsis antiqua* (a fern-like petiole) to *Cladoxylon* and has outlined a phyletic series connecting the Cladoxyleae with the Zygopterideae The most important of these intermediates is *Asteropteris noveboracensis* Dawson This note is scarcely the place for a discussion of these views, so it must suffice for the present to say that the evidence is quite suggestive although not conclusive

This single specimen of *Cladoxylon dawsoni* is from the Genundewa limestone member of the Upper Devonian Genesee shale in the vicinity of Canandaigua Lake in western New York At Saalfeld, Thuringia, the several species of *Cladoxylon* occur in strata regarded as Upper Devonian (*Cypridina* shales) in age

ENTOMOLOGY —*Some new Gyponas with notes on others* [1] E D BALL, University of Arizona

The writer made a preliminary revision of this group in 1920[2] with keys to the subgenera and species With several years of additional biological work on the Eastern and Florida forms, Ball and Reeves[3] made still further revisions and gave the food plants and distribution as far as then known Since coming to Arizona, the writer has continued the food plant studies and made further collections These have so increased the number of species in one group that a new key is necessary

KEY TO THE GENUS GYPONANA BALL (IN THE U S)

A Margin of vertex produced and foliaceous throughout
B No black spots on pronotum or hinge Reticulations absent on basal part of elytra or, if present, no white flecks between
C Species large, broad bilineate 1-*octolineata* Say
CC Species smaller, narrow, pale 2-*tenella* Sign
BB A pair of block spots on pronotum and another pair on the hinge (sometimes wanting), elytra densely reticulate (rugose) with white flecks between
D Head almost as wide as pronotum, the vertex broad and rounding, species large, with long rounding elytra
E Species without a black line under vertex
F Vertex slightly produced beyond the eyes then rounding, female segment with a rectangular median notch (S E), 3-*rugosa* Sign
FF Vertex rounding from the eyes, female segment with two oblique upturned thumb-like projections (Ariz), 4-*ampliata* Ball

[1] Received August 14, 1935
[2] Annals Ent Soc Amer 13 83 100 1920
[3] Annals Ent Soc Amer 20 488–500, 2 pl 1927

EE A black line under vertex margin, appendix broadly smoky and the male pygofers scarlet. . . . . (Aris.), 5-*pullata* Ball

DD Head definitely narrower than pronotum, which narrows anteriorly, vertex more or less angled.

G Vertex obtusely angled or almost rounding.

H Vertex very obtusely angled, species tawny green. . . . . (Aris.), 6-*ramosa* Kirk

HH Vertex almost a right angle, species pale. . . . . (Aris. & Utah), 7-*turbinella* Ball

GG Vertex right angled or acutely angled, species powdered . . . . (Utah), 8-*chadana* Ball

AA Margin of vertex and front angled, but not foliaceous.

I Small species (about 2 mm. wide), vertex about twice as wide as long.

J Extremely elongate with two oblique stripes on each elytron. . . . . (Calif), 9-*elongata* Ball

JJ Normal shape and without stripes. . (Aris. N. Mex.), 10 *delta* Ball

II Large species (about 4 mm. wide) vertex three times as wide as long . . . (S.W.), 11-*dorsalis* Sign

Gyponana rugosa Spang. This eastern species has not appeared in Arizona except in the higher mountain regions of the N. E. portions, which is the region of the deciduous oaks.

Gyponana ampliata Ball n. sp.

Big broad tawny-green, heavily reticulate with milky spots and the usual black dots on pronotum and hinge, closely resembling *rugosa*, paler, with the vertex rounding from the eyes, instead of produced and then rounding. Length ♀ 10 mm., width 3.5 mm.

Head practically as wide as pronotum, vertex shorter than pronotum, rounding directly from eyes, elytra broad, densely and evenly reticulate with apices rounding and appendix narrow. Female segment with the customary median quadrangular notch almost obliterated by the semicircular emargination of the lateral portions of the segment leaving oblique, thumb-like projections, which would form the margin of the notch if they were not turned up at right angles against the pygofers. The median portion broadly, shallowly bilobed. Male plates very narrow and widely separated at base, the inner margins broadly expanded, then narrowing to the rounding apices, beyond which the dark, spine-like styles project. In *rugosa* the plates are approximately parallel margined, 3 times as long as wide, and cover the styles.

Holotype[4] ♀ and 2 paratypes Santa Rita Mountains, July 6, 1933, allotype ♂ Chiricahua Mountains July 5, 1930, four paratypes Huachuca Mountains, June 15, 1930, and one Santa Rita Mountains, June 20, 1929, (labeled Tucson). All taken from oak in the high mountains of Southern Arizona by the author, most of them from the silver leaf oak (*Q. hypoleuca*). This species can be recognized by the very distinct genitalia of either sex.

[4] All types are in the author's collection.

Gyponana pullata Ball n. sp.

Resembling *ampliata*, but much narrower and more nearly parallel margined. Darker with a black line under the vertex and a broad, smoky appendix. Length ♀ 9 mm., width scarcely 3 mm.

Slender, parallel margined. Head as wide as pronotum, vertex as long as *ampliata*, but narrower so that it is more acutely rounding. Elytron long and narrow with rounding apex and a broad, smoky appendix. Female segment with a broad notch occupying nearly one-half the segment, the margin of the notch rounding back to the lateral angles, base of notch nearly filled by a broad bilobed pyramid that extends nearly as far as the segment. Male plates 2½ times as long as their individual width, each one convex below and angularly pointed, much exceeded by the long slender slightly knobbed styles. Pygofers and margins of abdomen scarlet.

Holotype ♀ and allotype ♂ Santa Rita Mountains July 6, 1933, nine paratypes taken with the types and in the Chiricahua and Huachuca Mountains, all taken by the author from the silver leaf oak in the mountains of southeastern Arizona.

This is the species Gibson keys out as *ramosa* Kirk, but cannot be the one Kirkaldy had in hand, as he does not mention the black line on vertex and states definitely that it had no appendix while this one has a broad appendix. This species does not occur at Nogales which is below the range of the silver leaf oak. The black line on vertex, smoky appendix, and red pygofers in the male, as well as the distinct genitalia, will easily separate this species. It rather strikingly, but superficially resembles the green males of *Gypona verticalis* in color and shape, but the reticulate elytra places it in a different group.

Gypona ramosa Kirkaldy. A narrow-headed species with a slightly angular vertex, but little over half as long as its basal width, a very narrow appendix and often showing a dark line around the apex of each elytron They are pale green, without the tawny reflection, and heavily white flecked. A few of them show traces of a sinuate dark band on pronotum but this character is not constant in any known species. The female segment has the median third deeply roundingly emarginate, with a bilobed tooth two-thirds the length of the notch.

Through the kindness of Mr. E. P. Van Duzee, we have examined the Gyponas of the Koebele collection from which Kirkaldy described this species. There were ten examples of a single reticulate-veined species. This proved to be the common form found on the two oaks (*Q. emoryi* and *oblongifolia*) that grow in the Nogales region. This species answers Kirkaldy's description in every particular and as suggested previously, the slightly angulate vertex, lack of appendix and deeply bisinuate female segment definitely eliminates the species described above as *pullata* on which Gibson placed the name.

Gyponana turbinella Ball n. sp.

Resembles *chadana*, larger, broader, with a broader vertex, slightly smaller than *ramosa* with a much longer and more strongly angled head. Pale green,

with white fleckings and a very slightly obtusely angled vertex. Length ♀ 8 mm., width 3 mm.

Head almost as long as the width between the eyes, narrower than the base of pronotum, vertex slightly shorter than pronotum, slightly obtusely angled, instead of acutely angled as in *chadana*. Elytra broad, rounding posteriorly, instead of narrower and almost acutely angled, as in *chadana*. Female segment with a narrow shallow notch with sloping margins, the median feebly bilobed projection about as long as segment. Male plates long, silky, gradually narrowing to rounding apices that exceed the slender pale styles.

Holotype ♀, allotype ♂ October 6, 1929 and six paratypes of various dates, Granite Dell, two from Yarnell Heights, and four from Superior, August 1, 1929. All taken by the author from the Chaparal oak (*Q. turbinella*) in the mountains of Arizona. This is the common species in the Chaparal region from Globe to Williams, Arizona, and appears again around St. George in Utah. The long, definitely triangular head will separate it from all but *chadana*, in which the head is still more pointed and the whole insect is covered with a whitish bloom.

Gyponana elongata Ball n. sp.

Still longer and narrower than *tenella*, with a head as wide as the pronotum. Pale green with four black stripes on the elytra. Length ♀ 7.5 mm. width 1.8 mm.

Head much wider than in *tenella*, as wide as the pronotum, eyes small, vertex broad, the anterior margin paraboloid or a trifle angled, the margin rather thick and short, scarcely foliaceous. Pronotum, with the lateral margins long and almost parallel, scarcely longer than the vertex. Elytra very long and slender, tapering toward the rounded apices—a few coarse, tawny reticulations scattered along posterior half of corium. Female segment scarcely longer than the adjoining one, broadly roundingly or slightly angularly emarginate, the lateral angles acute. Sometimes a median projection is faintly indicated. Male plates extremely long and slender, slightly tapering.

Color: Pale creamy, with a greenish tinge, ocelli red, a pair of widely separated dark dashes on the scutellum. A black stripe just outside the claval suture and another outside the inner fork of the outer sector. A smoky line around the apex. Below pale creamy.

Holotype ♀, allotype ♂, and eleven paratypes taken by the writer from Red Shanks (*Adenostoma sparsifolium*) at Pine Valley, California, July 6, 1931. Strikingly distinct on account of the black stripes.

Gyponana delta Ball n. sp.

Resembling *tenella*, but paler with a more angular head and a "U" shaped notch in the female segment. Extremely pale green fading to creamy translucent. Length ♀ 8 mm., width 2.5 mm.

Head definitely narrower than pronotum, the vertex roundingly angled with the apex bluntly rounding, the margin thick and not foliaceous. Vertex quite variable in length, varying from scarcely 2/3 to nearly the length of pronotum. Elytra about as in *tenella*, with very little reticulation. Female segment rather long with the lateral margins narrowing, the lateral angles rounding, posterior margin elevated over the ovipositor with a deep "U" shaped or slightly angular notch extending nearly half way to the base.

Male plates long, slender, tapering, exceeding the pygofers, but exceeded by the sickle like white styles The inner margins of the plates are thickened and reflexed and there is a row of long white spines towards the tip

Holotype ♀, allotype ♂, and 7 paratypes taken on snake weed (*Gutierrezia sarothrae*) at Paradise, Arizona Six paratypes taken on *Mortonia scabrella* at Tombstone, Arizona, June 13, 1932, all taken by the author In the angulate head this species resembles *Gypona angulata*, but that is a larger species with simple segment and no reticulations

Gyponana delta var **alomogorda** Ball n var

Form and structure of the species, but nymphs and adults powdery white, the darker hind wings slightly showing through the elytra

Holotype ♀, allotype ♂, and seven paratypes taken by the writer May 5, 1933, on a powdery white mint (*Paliomintha incana*) growing on the white sands at Alomogorda, New Mexico

Gypona villior Fowler is closely related to *verticalis* and like that species has males ranging from green all the way to black The extremely large and prominent veins of the elytra are its most distinctive character Nymphs and adults have been taken by the writer on the Apache plume (*Fallugia paradoxa*) from Prescott to the Huachuca and Chiricahua Mountains in Arizona

Gypona melanota Spangberg The study of a larger amount of western material in *unicolor* indicates that the broad, short eastern species is distinct from the longer Rocky Mountain one *G melanota* described from black males from New Jersey and Georgia is apparently the oldest name available for the eastern species

Prairiana orizaba Ball and Reeves This extremely long, slender Mexican species with the acute vertex has been taken by the writer (males only) from Brownsville, Texas, Granite Dell, and Santa Rita Mountains, Arizona

Prairiana moneta Van Duzee The writer has taken this California species with its broad foliaceous head and smoky male, at Bunkerville, Nevada, Yuma and Phoenix, Arizona They have all been swept from Bermuda grass in low, damp, alkaline areas and at low elevations

Prairiana sidana Ball n sp

Smaller and narrower than *moneta* Van Duzee with a more acute, but less foliaceous head Dead grass color in the female with the posterior margin of pronotum and all back of that smoky to shining black in the male Length ♀ 7 mm, width 2 8 mm, male smaller

Head slightly narrower than pronotum, the marginal line of pronotum and vertex continuous Vertex nearly paraboloid, slightly acutely angulate in male, as long as pronotum, much longer proportionally to its width than in *moneta* Front more inflated than in *moneta*, the vertex margin only slightly foliaceous across front Elytra short, rather broad in female, nearly parallel margined in the male, exceeding abdomen by less than the apical cells Female segment bisinuate, the median lobe much smaller than in *moneta* Male plates long, strap shaped, their points divergent, much longer than the dark spine-like styles Pygofers angled, but not as acutely as in *moneta*

Holotype ♀, allotype ♂, and 8 paratypes taken by the writer from a prostrate mat-like mallow (*Sida diffusa*) growing under the short grasses on the range slopes of the Baboquiviri Mountains, Arizona, August 29, 1931, and four paratypes taken under similar circumstances at Patagonia, Arizona, September 20, 1930.

There is no question but what the coloration of this and the other species of *Prairiana* is an adaptation to concealment in dead grass, but the food plant of this species is definitely the mallow creeping below the grass. Most of the species of this genus are more restricted than grass inhabitants usually are and it will probably be found that that restriction is due to food plants growing beneath the grass cover. In the case of *subta* both larvae and adults were found beneath a clump of grass on the plains of Colorado, but there was a mallow (*Malvastrum*) scattered all through the area.

Ponana sonora Ball n. sp.

Resembling a small pale *citrina*, straw-colored with a very narrow angulate head and six black spots in a semicircle. Length ♀ 8 mm, width 2.2 mm.

Head extremely narrow, scarcely wider than scutellum; vertex sloping, obtusely angled, one-half wider than long, the anterior margin rounding over to front, much broader than in *citrina*. Ocelli very large, scarcely their own width from the front margin of vertex and midway between the eye and the median line. The front inflated, strongly convex in both diameters; pronotum half longer than the vertex, broad behind, the lateral margins narrowing so rapidly as to form a semicircle with the front margin. Elytra more nearly parallel margined than in *citrina*. Female segment feebly bisinuate; male plates elongated spoon-shaped emarginate near the apex, concealing pale, slender styles with out-turned sickle-like tips.

Color: pale creamy or greenish straw. The ocelli very large and dark red, pronotum with four black spots on the submargin, which, with those on the hinges, form a semicircle. In the darkest specimens the disc of the pronotum is covered with minute dark points. Elytra uniform subhyaline straw with a smoky spot beyond the apex of clavus. Occasionally the eight points appear on the elytra as in *citrina*.

Holotype ♀ and allotype ♂ Santa Catalina Mountains, Arizona, September 19, 1930, and 9 paratypes taken at the same place at various dates from April on. The writer took these, with their white-haired nymphs, from a white-leaved perennial mallow (*Abutilon incanum*) growing on the south slopes of Sabino Canyon.

Ponana dohrni Signoret. The writer has taken nymphs and adults of this species from the white sandbar-willow (*Salix exigua*) in a number of places in southern Arizona. They are especially common on second growth sprouts.

Ponana candida Van Duzee, described from the Gulf of California, has been taken by the writer at the High Tanks on the Mexican border in Arizona. This beautiful black and white species was found as large nymphs and adults May 17, 1936, feeding on a six-foot white mallow (*Horsfordia alata*).

Ponana curiata Gib. The writer took a number of adults of this species

from a woody mat-like composite at the control station on the way up to Mt. Lemmon, Arizona, August 15, 1931. He took a pair at Redondo Beach, California, July 4, 1931, on a hairy, aster-like plant, (*Heterotheca grandiflora*).

Ponana marginifrons Fowler. This long, strikingly marked species with heavily margined nervures has been taken in abundance, both nymphs and adults, from the three-leaved sumac (*Rhus trilobata*). It is found in S. W. Colorado, S. E. Utah, Arizona and New Mexico, south into Mexico.

Ponona marginifrons var. **suilla** Ball n. var.

Head form and genitalia of *marginifrons* nearly. Size, shape of body and short elytra of *resima* Fowler. Uniform pale cinnamon with powdered elytra and greenish costa. Length ♀ 8 mm, width 3 mm.

Head about as in *marginifrons*, the vertex less sloping, slightly more angulate with the margin upturned like a hog's snout. Elytra much shorter and broader than in *marginifrons*, about as in *resima*, but without the prominent nervures of either. Females segment of an entirely different pattern from that of *resima*, but resembling *marginifrons* in the acute lateral angles, and the angularly produced median portion with a heavily chitinized projection at the apex.

Color: strikingly distinctive, uniform pale cinnamon. The elytra pruinose with the basal half of the costa greenish, the nervures concolorous. There are no spots or markings, except sometimes the round black dots back of the eyes and dash on hinge that are typical of the group.

Holotype ♀, and one paratype female from the Pinal Mountains above Superior, Arizona, August 1, 1929. Allotype ♂ and two paratype females from the same place July 11, 1935. All beaten from Chaparal Oak (*Q. turbinella*) by the writer.

In appearance this form is quite distinct and resembles *resima*, but in structure, except for wing length, it is close to *marginifrons* and will probably be found to be an adaptation to its food plant.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

GEOLOGICAL SOCIETY

522ND MEETING

The 522nd meeting of the Society was held in the Assembly Hall of the Cosmos Club, January 9, 1935, President W. T. Schaller presiding.

Informal communications.—Jewel J. Glass described what is probably the largest known zinnwaldite (a rare variety of mica) crystal, the portion recovered alone weighing 24 pounds. It was found at the Morefield mine in the celebrated pegmatite region near Amelia Court House, Virginia. This mine has also produced germanium-bearing topaz crystals of unusual size, some weighing as much as 500 pounds.

George Otis Smith described crack systems in river ice in Maine due

principally to changes of level of the water. Very little movement was found along the cracks. Although offsets of certain cracks occurred along other cracks these did not indicate lateral motion of the ice blocks. Discussed by G. F. LOUGHLIN.

M. A. PENTZ described the stratigraphic sequence of rocks and clays found by boring in the Carolina bays. No evidence was found supporting a meteoric origin of the Carolina bays; the sediments lie undisturbed at a shallow depth.

Program.—EDWIN D. MCKEE: *Some observations on the Middle Permian marine formations of northern Arizona.* The numerous lithologic types included in the formation known as the Kaibab limestone, in northern Arizona, include marine sandstones, bedded cherts, "redbeds," white cross-bedded sandstones, gypsum deposits, and several types of limestones. The complex interrelationships between these various types and the transitions from one type to another may be observed and traced in numerous localities in this region, especially along the walls of the Grand Canyon and the Little Colorado Canyon. Here then is found an exceptionally fine area for determining various features of Permian deposition. In a section of normal Kaibab limestone there are three distinct limestone units or members characterized by distinctive lithologic and faunal elements. These are separated from one another by sandstones and probably represent distinct invasions of the sea. The limestones and intermediate sandstones control to a great extent the development of topographic features, and are well expressed in typical canyon profiles of the region. In each limestone member of the Kaibab formation the fauna is represented by two facies. These are best described as the normal open sea facies, with brachiopods of the *Productus* group predominating, and the brackish water facies composed of pelecypods and gastropods with *Bellerophon* most conspicuous.

The lower member of the Kaibab limestone is separated from the middle limestone or upper cliff-forming member by an unconformity which has been noted in several localities. The hiatus represented probably is not great but involves a time of slight erosion before the second sea invaded the area. The uppermost limestone differs greatly in lithologic character from the middle limestone and is separated from it over wide areas by a relatively thin bed of crosslaminated sandstone. No evidence of an erosional break has been noted between these limestones but the contrast between their faunas is marked. The details concerning the nature of the transitions which occur both vertically and laterally between the sandstones, limestones, bedded cherts, and gypsum deposits are best brought out by three series of sections made along general east-west lines located (1) through the deep canyons south of Flagstaff, Arizona, (2) along the rim of Grand Canyon, and (3) near the Arizona-Utah border. The work on this problem is still in a preliminary state, but enough has been done to indicate many significant features regarding Middle Permian sedimentation, paleogeography and ecological conditions. (*Author's abstract.*) Discussed by Messrs. BUTTS, MERTIE, MISER, GOLDMAN, HENBEST.

G. A. COOPER: *Stratigraphy of the Tully limestone, New York.*

J. C. REED and J. M. HANSELL: *Quicksilver deposits near Little Missouri River, Southwest Arkansas.* Cinnabar was discovered near the southern border of the Ouachita Mountains in southwestern Arkansas in 1930 but was not identified until June 1931. The quicksilver district is now known to have an east-west length of about 30 miles and an average width of less than a mile. The part covered in this paper is concerned with a 12-mile segment of the district near the Little Missouri River, and includes the 3 mines, Gap

Ridge, Parker Hill, and Parnell Hill, from which most of the production to date has come The principal rocks exposed in the district are shale and sandstone of the Atoka, Jackfork, and Stanley formation, of Pennsylvanian age, which aggregate many thousands of feet in thickness The rocks have been deformed by close folding and thrust faulting and the three formations form several east-northeast trending belts

All the cinnabar deposits are in a northward overriding thrust block that is cut by northeast trending cross faults and is deformed and fractured by cross folds The cross folding has not yet been adequately explained but it apparently is related to the thrusting The cross faults appear to be tear faults formed during the thrusting Mineralization occurs principally in a sandstone member of the Stanley shale but locally is found at other horizons in the Stanley and in the overlying Jackfork sandstone The cinnabar fills fractures related to the cross folding, and the linear distribution of the ore occurrences is believed to have been due to mineralizing solutions ascending along the thrust fault until they reached fractured sandstones of the Stanley whence they followed these permeable beds toward the surface Some of the cross faults may be worthy of prospecting (*Authors' abstract*) Discussed by Messrs WASHBURNE, HESS, FERGUSON, HENDRICKS, MISER, HEWETT

523RD MEETING

The 523rd meeting was held in the Assembly Hall of the Cosmos Club, January 23, 1935, President SCHALLER presiding

Informal communications —H D MISER reported that the urgent need for more manuscript papers to be published in the Bulletin of the American Association of Petroleum Geologists had been brought to the attention of the Geological Society of Washington Authors having suitable manuscripts may submit them to Mr J P D HULL, Business Manager, Box 1852, Tulsa, Okla

D F HEWETT stated that in connection with field work in the mineral resources near Boulder Dam during the spring of 1934, observations were made on the north and south ends of Avawatz Mountain which show that post-Miocene thrust faulting on a large scale is present west of the Death Valley trough as well as east of it The Garlock fault is interpreted as a tear fault which turns southward around Avawatz Mountain and limits a block of pre-Cambrian gneiss that is thrust over Miocene sands and volcanic rocks

Program —L W CURRIER *Structural features of the Illinois-Kentucky fluorspar field* The areal structural pattern due to doming and normal faulting, together with the unusual occurrence of numerous igneous bodies, led to an earlier belief by several geologists that the uplift of the region resulted from a deep-seated intrusion of magma, and that the faults represent a subsequent settling of the dome The striking symmetry of the Hicks dome, a small structure in the northwest part of the field, is highly suggestive of a laccolithic intrusion, but the general fault pattern of the field as a whole seems more clearly a result of broader regional warping because (1) of the lack of a concordant relation between the fault trends and the longer axis of the dome, (2) the general absence of dikes from fault fissures, (3) the offsetting of dikes by faults of the prevailing northeast-southwest system, and (4) the continuance of narrow faulted belts from this area to southeast Missouri on the west, and central and eastern Kentucky on the east It seems likely that the area experienced regional warping, effects of which were local emplacement of the magma beneath the domed area, and intrusion of the dikes, continuing or later crustal disturbance imposed the major

fault systems, and in these fissures were deposited vein minerals of hydrothermal origin. Incidentally, an interesting suggestion has been made by Bucher, who speculates concerning an incipient geosynclinal trough involving the upper part of the Mississippi embayment area. The axis of this trough had it developed beyond the embayment, would, according to him, probably have followed the zones of crustal tension now marked by fault systems that extend eastward from the fluorspar field into central and eastern Kentucky. It is to be noted that the highly fractured fluorspar field lies at a sharp bend in this postulated axis.

An interesting recent development has been the exploitation of another type of fluorspar deposit, designated by some as "blankets," and by others as "bedded deposits." The connotations of these terms are misleading and the writer prefers to call them "bedding replacement deposits" since it is believed that they were formed by the replacement of limestone along bedding planes, directly beneath impervious shale or dense limestone beds. These deposits are not obviously connected with prominent faults, but recent work seems to indicate that solutions arose along minor fractures of little or no displacement, connected with minor faults, and these in turn with a major fault zone. Solutions rising along small fractures in the locally warped Cave in Rock fluorspar district were impounded or greatly impeded beneath the impervious beds, and lateral replacement of the limestone took place with preservation of the bedding of the limestone producing a "coon-tail" type of banded ore. The writer dissents from the "diffusion banding" theory of Bastin as a major process for several reasons that will be treated in a later paper. (*Author's abstract.*)

M. King Hubbert: *Determination of certain structural features in Illinois, Kentucky, and Alabama by electrical resistance methods.* The work herein discussed was conducted chiefly during the summer of 1934, though it was a continuation of work begun earlier for the Illinois State Geological Survey. Two distinct areas were involved: (1) the fluorspar-bearing district of southern Illinois and of northwestern Kentucky, and (2) the limonite iron-bearing area around Russellville in northwestern Alabama. Most of the work was done in the fluorspar region and only a short amount of time was devoted to experimental work in Alabama. Three methods were used: (1) the Wenner four-electrode technique with Gish-Rooney apparatus for the determination of specific electrical resistivity of the ground. (2) equipotential-line mapping, and (3) potential-drop-ratio depth correlations.

The resistivity method was used for locating faults in Illinois and Kentucky. The resistivity of the rocks on the opposite sides of a fault is frequently quite different. This fact enables one to locate faults not otherwise known by making cross-country traverses on which resistivity measurements effective to depths of the order of 100 feet are taken at intervals of 100 feet. Faults are frequently disclosed by abrupt changes in the readings of specific resistivity in these traverses.

An equipotential-line map was made of one area in Kentucky which was crossed by a dike and by a complex of faults, and was known to be fluorspar and galena bearing. Most of the faults produced no noticeable effects. One fault, however, produced a very severe distortion of the equipotential lines. These lines in this case changed direction abruptly in the vicinity of the fault and ran parallel to it for a distance of 100 feet or more. This indicated a very highly conductive zone along this fault. Galena is the only mineral common to the area which seems sufficiently conductive to account for this anomaly.

Work by the potential-drop-ratio method was conducted in Alabama The stratigraphic column there was Chert gravel underlain by limonite with massive limestone beneath All of these, it proved, were very highly resistive with very little contrast Numerous depth profiles by the potential-drop-ratio technique gave a faint correlation, but one not distinct enough to make the method seem reliable as a potential substitute for test holes in locating ore (*Author's abstract*) Contributors to the discussion of the two papers of the regular program at the conclusion of the second were Messrs SCHALLER, HENDRICKS, BASTIN, FERGUSON, GOLDMAN, HEWETT, R C WELLS, HENBEST

524TH MEETING

The 524th meeting was held in the Assembly Hall of the Cosmos Club, February 13, 1935, President SCHALLER presiding

The following resolution was presented by Dr T W STANTON and unanimously adopted by the Society WHEREAS, Dr DAVID WHITE, a charter member and Past President of the Geological Society of Washington, died at his home in this city February 7, 1935, at the age of 72, it is fitting that the Geological Society should pause for a moment in tribute to the memory of one whose splendid character, innate ability and outstanding accomplishments in the broad and varied fields of his life work have been and are an inspiration to all who knew him As another colleague has said of him, Dr White "has long been the foremost Paleozoic paleobotanist on this continent and perhaps in the world His work here was not merely systematic and descriptive but was interpretative from the beginning He was a stratigraphic paleontologist of the highest rank He was our foremost authority on the origin and evolution of coal His great generalization, known widely as the carbon ratio hypothesis, was an outgrowth of his studies on the origin and evolution of both coal and petroleum It established a 'dead line' beyond which oil pools will not be found This has great economic significance It alone stamps him as a rare original investigator and thinker He contributed significantly in the field of isostasy He administered an important unit of government during the Great War in such fashion as to make it most useful during the crisis" These quoted words suggest only a few of the varied fields in which he excelled Here in the presence of his friends it is not necessary to enumerate the many honors and responsibilities that came to Dr White during his life time They were all received by him most modestly To those of us who have known him through most of his long service in Washington—almost half a century—he was an inspiring leader, a helpful counsellor, an ever faithful friend

THEREFORE, it is moved that these few and most inadequate words of appreciation be incorporated in the minutes of this meeting and that the Secretary be instructed to convey to Mrs White the sincere sympathy of the entire membership, and a copy of these resolutions

Informal communications—C S Ross reported that the tentative conclusion that euhedral analcite resulted from the alteration of glassy volcanic ash, probably deposited in a saline lake, was confirmed by the recent studies of Bernard M Moore The material studied by both Ross and Moore came from the vicinity of Wikieup Post Office, western Arizona Microscopic examination showed all stages in the alteration of glassy volcanic ash to a nearly pure analcite rock One section showed tiny analcite grains forming within typical glassy ash grains Discussed by Messrs GOLDMAN, RUBEY, SCHAIRER, MILTON

A. H. KOSCHMANN stated that work in slaty rocks in southeastern Alaska showed that the usual relationships between cleavage and structure—uniformity of dip and strike over large areas—did not apply. The cleavage varied from place to place within a short distance. In general it was found to be parallel to the limbs of folds. In extreme cases it was even found dipping in opposite directions in alternate layers varying from an inch up to one foot in thickness. Discussed by Mr. BRADLEY.

J. P. MARBLE stated that the Committee on Determination of Geologic Time desires to secure samples from fine-grained sills, flows or dykes of known geologic provenance, for examination of the "Helium Method" at the hands of Dr. W. D. URRY, of the Massachusetts Institute of Technology. Samples should be from fresh exposures, and not taken from or near old surfaces. They should be sent to Prof. A. C. LANE, Chairman, Tufts College, Cambridge, Massachusetts, or to J. P. MARBLE, U. S. Geological Survey.

Program.—P. D. TRASK and H. E. HAMMAR: *Organic content of sediments.* This paper has been published in full in Proceedings of the American Petroleum Institute Production Bulletin 214, 1934, and in the Oil and Gas Journal, vol. 33, no. 27, pp. 43–46; no. 28, pp. 40–41; no. 29, pp. 36–39, Nov. 22, 29, Dec. 6, 1934. It is essentially a progress report which presents data about the distribution of organic matter among sediments from several oil-producing areas in California, Wyoming, Colorado, Montana, Kansas, Oklahoma, and Texas. The report explains briefly the methods of determining the organic content of sediments; and one method, that of ascertaining the degree of oxidation by means of chromic acid, is described in detail. Sediments, in general, contain little organic matter. The average organic content is about 1.5 per cent, and relatively few sediments contain more than 4 per cent. Since the average organic content of recent marine sediments is about 2.5 per cent, it would seem as if the loss in organic matter during burial is of the order of magnitude of 50 per cent. The scarcity of sediments containing more than 4 per cent organic matter indicates that a large organic content is not required for the generation of petroleum in commercial quantity, even in consideration of the fact that the organic content of the sediments is less now than at time of deposition. However, the association of so many oil horizons with sediments, like the Miocene of California, the upper Cretaceous of Wyoming, the Cherokee shale and Chattanooga shale in Oklahoma, and the Eagle Ford shale in Texas, which contain considerable more organic matter than the general average for sediments, indicates that relative richness (but not necessarily extreme richness) is a favorable indication of source beds. On the other hand, the organic content is not an absolute index of source beds; as some rich sediments are not associated with oil horizons, and some oil horizons are not associated with rich sediments. Evidently other factors, like the volatility, the degree of reduction of the sediments, or the ease of migration of oil out of the sediments, have to be considered. In fact, some of the data already obtained seem to indicate that comparatively high volatility and high degree of reduction are favorable indications of source beds. (*Authors' abstract.*) Discussed by Messrs. SCHALLER, WELLS, FAHEY.

P. J. SHENON: *Utah earthquake of March 24, 1934.* An earthquake of major intensity which centered near Kosmo, Utah, at the northern end of Great Salt Lake, was felt in 4 states over an area of about 150,000 square miles on March 24, 1934. The first and strongest shock was felt for 650 miles in an east-west direction and for 400 miles in a north-south direction. The intensity in the epicentral area was 8 to 8+ of the Modified Mercalli scale of

1931 and 8+ to 9− of the Rossi-Foral scale. The first shock was recorded in the epicentral area at 8:06 A.M., M.S.T. It was followed by hundreds of aftershocks but no foreshocks were reported. The earthquake was strong enough to alarm inhabitants throughout an area having a radius of nearly 100 miles. Many people became dizzy or nauseated and most people became very sensitive to the smaller shocks that followed the first disturbance.

Considerable property damage as well as loss of life was avoided only because of the sparsity of population in the epicentral area. All chimneys were shaken down in the epicentral area. Brick and stone buildings at Snowville were damaged and some damage was done as far away as Salt Lake City, where cracks developed in some office buildings. The tracks of the Southern Pacific railroad, 3 miles east of Kosmo, were displaced vertically about 4 inches.

A number of ground cracks developed in the epicentral area. Most of the fractures were in the salt flats or in poorly consolidated gravel and related rocks that probably belong to the Lake Bonneville sediments. The ground cracks extended in an east of north direction for at least 5 miles although no one fracture was continuous for a great distance. Rather there was a tendency for the cracks to develop en eschelon patterns. All of the fractures noted by the writer had nearly vertical dips and so far as known the movement along them was entirely vertical. Four distinct fractures crossed the road about 3 miles north of Kosmo. They were about ½ mile apart. The vertical displacement along these fractures ranged from about 2 inches to 20 inches and, except for one, all were displaced downward on the east side. The west side dropped about 3 inches along the fault which crossed the road nearest to Kosmo.

Numerous springs developed in the epicentral area as a result of the earthquake. So far as known all of them arose along well defined fractures and most of them formed in the salt flats. Where the flow was localized along fractures mud cones were built up at the surface. Some of the springs that developed during the earthquake flowed as much as 0.5 sec. ft. of water. It is believed that settling and readjustments in the saturated material along the old shore line of Great Salt Lake was responsible for the development of the springs.

The earthquake was probably caused by movements along faults in Hansel valley. All of the fractures showing displacements in the epicentral area were in gravel and related rocks; hence it cannot be definitely stated that they were not formed by slumping and settling as the result of earthquake vibrations. However, the close association of the fractures with the terraced forms and lines of old springs strongly suggests that the recent displacements followed old surfaces of movement. This in turn suggests that the fractures may have been caused by adjustments in the bedrock below and that the faults that define Hansel Valley are still active and that the recent earthquake was caused primarily by movements along these faults. This is supported by the fact that this vicinity has been an active seismic center for many years. (*Author's abstract.*) Discussed by Captain HECK and Mr. C. S. ROSS.

G. W. STOSE and ANNA I. JONAS: *An erosion remnant of a great overthrust sheet in the Highlands near Reading, Pa.* The Reading-Boyertown Hills of Pennsylvania are a part of the Appalachian Mountains and trend northeast between the Great Valley on the north and the Triassic belt on the south. From their western end in South Mountain, southwest of Wernersville, they are continuous across eastern Pennsylvania into the Highlands of New

Jersey and into New York. The present paper sets forth the results of a structural study of the Reading-Boyertown Hills north of the Triassic rocks during which the mapping of the Paleozoic rocks has been revised and extended and the overthrust nature of the mountain belt has been worked out.

The oldest rock in these mountains is a pre-Cambrian graphitic gneiss of sedimentary origin with marble lentils. It is invaded by an igneous complex also of pre-Cambrian age. The Lower Cambrian Hardyston quartzite, with an estimated thickness of 300 feet, unconformably overlies the pre-Cambrian rocks. It includes a basal arkosic pebbly quartzite overlain by thick-bedded vitreous quartzite, the upper part of which contains *Scolithus linearis*. The limestone of the Great Valley includes from the base upward Lower Cambrian Tomstown dolomite, Middle Cambrian Elbrook limestone, Upper Cambrian (Ozarkian of Ulrich) Conococheague limestone, and the Ordovician Beckmantown and Leesport limestones, overlain by Martinsburg shale of Trenton to Eden age

The Irish Mountain mass and Lock Ridge, which form a front line of hills, are anticlinal uplifts of pre-Cambrian rocks and Lower Cambrian quartzite which dip normally under Cambrian (Tomstown) limestone. The rest of the mountain area from its end southwest of Wernersville to South Mountain south of Allentown, a distance of over 50 miles, and probably across Pennsylvania to Easton, is part of a great overthrust sheet, here called the Reading overthrust, which has ridden northwestward on a flat fault plane in its crystalline core over Lower Paleozoic rocks which are now exposed in Oley Valley and in many other mountain valleys. Evidence of the overthrust character of the mountain belt is based on structural and stratigraphic discordance of the mountain rocks with the adjoining rocks of the valley border, and mylonites on the borders of the thrust block where pre-Cambrian rocks and quartzites have been ground out into mylonites on the sole of the overthrust sheet.

Many small detached areas of the main overthrust sheet, or klippen, occur on the borders of the mountains. The largest is Neversink Mountain lying south of Reading, which is a narrow anticline of pre-Cambrian rocks bordered on both sides by much crushed quartzite. The older rocks of this mountain lie on Middle Cambrian (Elbrook) limestone. The mountains are dissected by many steep-sided flat-bottomed valleys in some of which limestone and quartzite are exposed. These valleys are interpreted as windows in the overthrust sheet which has been cut through by erosion to the underlying limestone. Evidence for this is in the blocks of chert found in most of the valleys, the chert having been formed by silicification of the limestone along the thrust fault, and the presence of granite and quartzite mylonites at the valley borders. The roots of the thrust are buried under the Triassic rocks dropped down by the Triassic border fault.

It is suggested that Jenny Jump Mountain, N. J., and the Highlands of New Jersey lying northwest of the Green Pond Mountain syncline of Silurian and Devonian rocks are part of the overthrust block observed in the Reading-Boyertown Hills. The Highlands of New York which lie southeast of the Green Pond Mountain syncline trend southwestward and pass under the Triassic sediments southeast of the strike of the overthrust sheet here described. The youngest rock involved in the overthrust is Martinsburg shale, hence the age of the movement is at least post-Eden. It is believed that the thrust is Appalachian in age. (*Author's abstract.*) Discussed by Messrs. C. S. Ross, H. D. Miser.

525TH MEETING

The 525th meeting was held in the Assembly Hall of the Cosmos Club, February 27, 1935, President SCHALLER, presiding.

Informal communications.—A. H. KOSCHMANN showed a slide illustrating a phenomenon very probably caused by pressure exerted by growing crystals. On Annette Island, Southeastern Alaska, pyrite crystals in a calcareous shale have tapering wedges of quartz on two and some on four sides. The longest pyrite-quartz crystal is 1.7 inches in length. Molds show that a film of quartz also completely surrounds the pyrite. The quartz shows no crystal outline and it is believed that the wedge-shaped openings now occupied by quartz were formed by the growing pyrite. Discussed by Mr. BEVAN.

Program.—L. G. HENBEST: *Cyclical sedimentation and the stratigraphy of the Bloyd shale, Morrow group, near Fayetteville, Arkansas.* The Bloyd shale around Fayetteville, Arkansas, contains three well known members, namely, the Brentwood limestone—at or near the base, the Baldwin coal—near the middle, and the Kessler limestone—about 50 feet below the top. The general character of the Bloyd shale has already been described and is generally known, but certain inconspicuous details of the stratigraphy have a historical significance that has escaped attention. This is particularly true of the sediments associated with the Baldwin coal.

The Brentwood limestone in this vicinity is typically massive in the lower part but grades upward into alternating marine marl and limestone beds. These marine beds are abruptly terminated above at a sharp, unweathered contact, above which lies 15 feet, more or less, of terrestrial, variously sandy shale. The top of the terrestrial shale is weathered and grades upward into the underclay of the Baldwin coal. The coal is followed by 0–5 feet of terrestrial, plant-bearing, carbonaceous shale and this in turn by a limy, conglomeratic, quartz pebble bearing marine sandstone, generally 5 feet or more thick. In northeast Fayetteville the limy sandstone is richly fossiliferous, but its original character is almost completely obliterated by weathering in the natural outcrops.

The stratigraphic succession described above is so closely similar to that which characterizes the Pennsylvanian cyclothems in Illinois that it may confidently be considered the same in origin. In certain respects the example near Fayetteville is even more suggestive of the opinion which the writer has held for some time that *the Illinois cyclothems were produced by saltatory but always downward movements of basins of deposition that were open to marine invasion as a consequence of each subsidence.* According to this hypothesis, each cyclothem appears to have begun with a relatively rapid and even depression of the basin, accompanied by a similarly rapid marine invasion and recorded by an advance marine deposit composed of macerated and decomposed plant material, mud, and remains of an advance marine fauna. A brief period of crustal stability followed and two different types of sedimentation (marine and deltaic) began simultaneously to fill the shallow basin and to force a slow retreat of the strand line. In marine areas that received little silt and afforded a normal marine fauna, limestone and limy marls were laid down, but in areas where large amounts of land-derived sediments were received and sudden, drastic changes in the composition of sea water were common, barren clays and silts were deposited. In such localities as the last, sporadic invasions of marine organisms or the drifting in of organic remains from land or sea furnished nuclei for subsequent formation of concretions, both calcareous and sideritic.

The rapidity and wide extent of the submergence that initiates the cyclothem is evidenced by the abrupt change from terrestrial to marine deposition, general absence of erosion at contact, and parallelism of the coal and marine beds. The subsidence which initiated the cyclothem was accompanied in all likelihood by uplift of adjacent positive areas. As a consesequence the streams were rejuvenated and began vigorously to degrade the uplands and to extend deltas into the basin, thereby causing a simultaneous migration seaward of the strand line and the zones of lime, marl, barren clay, and terrestrial deposition. The migration must have been interrupted or its record varied by exceptional floods, climatic cycles, biologic changes, shifts in ocean currents, or combinations of all or part of these.

The advancing terrestrial deposits were generally cross-bedded, channeled and filled, locally peaty, and generally characterized by great variation in composition, texture, and bedding structure. In their areas of alluviation the master streams or their distributaries evidently migrated from side to side as they advanced and in places cut deeply into or through their own sediments and into the preceding marine deposits, but they generally met strong resistance wherever they encountered the thick peat bed at the top of the preceding cyclothem. Inasmuch as the bottoms of the channels evidently were rarely or never exposed to air and as the channels were constantly migrating, the sediments beneath the intraformational unconformities were not weathered, therefore producing the fresh contacts which commonly are found in Illinois at this position. Back of the advancing front, the low-lying, poorly drained, alluvial plain became a favorable place for the formation of a soil (the *anlage* of most underclays), the growth of a lush flora, and the accumulation of peat if the climate was propitious. Locally, a veneer of plant-bearing clay or silt was deposited on the peat and ended the cyclothem record, possibly heralding the disturbance of land levels associated with approaching subsidence.

The dynamic background for this deformation is not clearly inferable at present, but circumstances strongly suggest a connection between the surface processes of simultaneous degradation and aggradation of adjacent areas and the periodicity of crustal yielding. Though covering thousands of square miles in some instances, the load of water-logged sediment composing a cyclothem rarely exceeded 50 to 125 feet, which is about one-sixth to one-twelfth the load supposed to be capable alone of causing an isostatic adjustment. In an area weakened by previous failures and enduring accumulating diastrophic stresses, a light load should be capable of hastening failure and promoting a more complete though temporary adjustment to the larger diastrophic forces at work in the region generally. Accordingly, isostatic adjustment is here regarded as an immediate, dynamic cause of the cyclothem and a factor whose importance as an agent promoting periodicity of deformation was much greater than the relative magnitude of its force. In relation to the more remote and fundamental causes of the extensive diastrophism of the time, isostasy was probably a sort of accessory-after-the-fact agent rather than a primary cause and possibly negligible at that.

The black, fissile, marine shale which overlies some coal beds and lies at the base of the cyclothem in which it occurs probably originated from bottom gel in the invading sea. This proposed origin for the fissile shale accounts for the association of macerated plant material, very fine to submicroscopic carbonaceous substance, and marine shells, and accounts for the finely lamel-

lar character of this shale. Except when strongly built, marine shells in these fissile shales are generally flattened by subsequent compaction of the sediments.

For practical and theoretical reasons the boundary between cyclothems is placed at the beginning of marine deposition above the coal zone instead of at the base of the advance, terrestrial deposits. (*Author's abstract.*) Discussed by Messrs. MISER, WILLIAMS, HENDRICKS, GILLULY, TRASK, SEARS, RUBEY.

Captain N. H. HECK: *Investigation of strong earthquake motions in California.* By means of earthquake maps of the earth as a whole and of the United States, the relation of earthquake activity in California was clearly brought out. A comprehensive attack on earthquake problems is now in progress, which, while primarily for the engineers, has many points of interest to the geologist. For the last two years, measurement of strong earth motions has been in progress by means of short period instruments known as accelerographs, long period instruments known as displacement meters (both types recording photographically) and visually recording instruments known as the Weed strong motion instruments. The present instruments are not capable of recording the strongest earthquakes that have occurred in California, but before long such instruments will be available. All of these are operated only during an earthquake. Features of the instruments include automatic starting and stopping (starting due to the earthquake itself), time marking, adequate damping, and naturally, low magnification.

Beginning with the Long Beach Earthquake, valuable records have been accumulated. Among those of special interest to geologists are those from the Long Beach Earthquake of March 10, 1933, which show changes in geological structures in different stations, a very different type of record obtained in the Imperial Valley, and records obtained in the same vicinity on several types of instruments. The latter has made it possible to determine the validity of a method of integration perfected by Mr Frank Neumann of the Coast and Geodetic Survey, which among other things, brings out the fact that at the very starting of an earthquake and in the immediate vicinity of the epicenter, periods ranging from 15 seconds to nearly a minute occur.

Triangulation and leveling have been quite well extended in California to cover the principal areas where crustal movement is to be expected. A program with repetition of measurements at reasonable intervals has been developed. The possibility of tilting along major faults is being tested through tiltmeters at the University of California.

The various activities are made possible through regular and P. W. A. funds assigned to the Coast and Geodetic Survey. Cooperating agencies include the Carnegie Institution of Washington, California Universities, the Structural Engineering Organizations, Bureau of Standards and many others. None of the recent earthquakes have involved important geological changes, therefore the United States Geological Survey and similar organizations have not been required to take an active part in this particular program, but the need for such geological studies may come at any time. (*Author's abstract.*) Discussed by Messrs. RUBEY, TRASK, CALLAGHAN.

W. D. JOHNSTON, JR., and G. TUNELL, *Secretaries*

SCIENTIFIC NOTES AND NEWS

Prepared by Science Service

Notes

U. S. Naval Observatory.—The greatest outburst of sunspot activity since last summer swept the sun recently, photographs obtained at the Naval Observatory indicate. Above the sun's equator, on what would be the northern hemisphere of the earth, a giant streamer extended from 47 to 82 degrees of longitude, or over one-sixth of the sun's diameter. The streamer's length was approximately 144,000 miles. In the southern solar latitudes were five separate groups of sunspots, some containing as many as three spots.

Coupled with the increased sunspot activity there was a succession of moderately severe magnetic storms, according to reports from the U. S. Coast and Geodetic magnetic station at Cheltenham, Md. "The storms," reports W. M. McFarland, "seem to be a recurrence of the magnetic activity of late August and late July. There is often an interval of about 27 days between these recurrences, and sometimes such a group of magnetic disturbances will continue to occur for several years with this 27-day interval between the appearances. The present group of disturbances seems to have appeared first about two months ago."

National Bureau of Standards.—Dr. Lyman J. Briggs, Director of the National Bureau of Standards, recently announced the formation of a new section for research on organic plastics. The increasing use of these materials by Government departments, coupled with a growing volume of requests for information, made a survey of their sources, properties, and uses imperative. Dr. Gordon M. Kline, the chief of the new section, has been a member of the Bureau's staff for six years, during five of which he has been engaged in research on plastic materials.

Mr. Ralph W. Smith of the weights and measures division of the National Bureau of Standards left Washington on October 6 to attend a meeting of weights and measures officials of the State of California in Los Angeles, October 16, 17 and 18. On November 6, 7, and 8 he will represent the Bureau at a meeting of weights and measures officers of the State of Michigan at Flint, Michigan. At the Los Angeles and Flint meetings Mr. Smith will speak on the activities of the National Conference on Weights and Measures with particular reference to specifications and tolerances for weighing and measuring devices.

Dr. Milton Harris, the research associate of the American Association of Textile Chemists and Colorists at the National Bureau of Standards has returned from Europe where he visited the laboratories of the British Wool Research Association, the Shirley Institute for Cotton Research, the British Leather Manufacturers Association, and the Leeds University in England; and the Conservatoire National des Arts et Metiers in France.

North American Council on Fishery Investigations.—This organization held its 22nd meeting September 17 to 19, in the Department of Commerce Building. The Council is composed of the heads of fishery services in France, Newfoundland, Canada, and the United States, and eminent fishery scientists attached to their respective organizations. During recent years annual meetings have been held for the purpose of coordinating investigations of

the various countries in North Atlantic waters where fishermen from respective countries share in the sea fisheries of the region. Representatives of the United States Government were FRANK T. BELL, Commissioner of Fisheries; Dr. H. B. BIGELOW of the Woods Hole Oceanographic Institution, Chairman of the Council; and ELMER HIGGINS, Chief of the Bureau's Division of Scientific Inquiry. R. H. FIEDLER, Chief of the Division of Fishery Industries, and Messrs. O. D. SETTE, W. C. HARRINGTON, R. A. NESBIT, and JOHN R. WEBSTER of the Bureau's North Atlantic staff of biologists attended the meeting and participated by presenting reports on scientific investigations during the past year. Fishery experts of Newfoundland, Canada, and the United States presented technical reports on their investigations during the past year dealing with cod, haddock, mackerel, herring, Atlantic salmon, and other important species, and dealt extensively with improved methods of investigation regarding currents, temperatures, and chemical composition of sea water that affect the success of the various fisheries. Plans for collecting improved fishery statistics as a guide to industry were also developed.

At the close of the session the Council adopted a resolution calling upon the Government's representative to draft an international treaty for the protection of the great North Atlantic haddock fishery. Reports of investigators indicated that this fishery, worth to the fishermen more than four and one-half million dollars in 1933, is facing commercial destruction. U. S. Bureau of Fisheries investigators have demonstrated that a tremendous destruction of undersized, unmarketable fish occurs in trawl fishing. In some years this destruction has amounted to two-thirds of the total number of fish caught. Practical experiments at sea have shown that an increase in the size of the openings in the net from 3 inches as now used to 4¾ inches will permit the escape of the great majority of these young fish and thus reduce the strain of the fishery by more than one-half. On the basis of these findings the Council recommended to the governments of the nations concerned the drafting of a treaty to require the use of nets of larger mesh.

National Park Service.—VERNE E. CHATELAIN has been designated as Acting Assistant Director in charge of the Service's newly-established Branch of Historic Sites and Building, Washington Office. Authorization for establishment of this branch was contained in the 1936 Interior Department Appropriation Act.

Dr. FRITIOF M. FRYXELL, formerly of the Washington Office, has been transferred to the Service's Field Educational Division at Berkeley, California, where he will plan museum exhibits for western national parks.

BEN H. THOMPSON, special assistant to the Director, has returned to Washington Headquarters from the West, where he accompanied Director Cammerer and members of the Senate Committee investigating proposed national park sites.

KENNETH B. DISHER, is now connected with the Eastern Museum Division, Washington Office, lining up the Bureau of Reclamation Exhibit for the new Interior Department Building Museum. Mr. Disher came to Washington from the Chickamauga and Chattanooga National Military Park, for which area he planned museum exhibits. During the summer of 1934 he served as a ranger naturalist at Grand Canyon National Park and was stationed at the Wayside Museum.

Asiatic grasses for the West.—Erosion-checking grasses and other plants that can fight the droughts, winds and occasional floods of the Great Plains

area have been sought in Asia by three expeditions of the U. S. Department of Agriculture. Now, the explorers' work finished, the seeds and cuttings are being tested under field conditions at four stations in the West by agronomists. The expeditions were in Asia at various times during the past two years. One, under H. G. MacMillan and J. C. Stephens, collected in Manchuria. A second, under the direction of H. L. Westover and C. R. Enlow, traversed Russian Turkestan. The third, under Prof. Nicholas Roerich, worked in northern China. The scientific spoils thus far checked number well over 2,000 lots of seed and planting stock, with some shipments yet to be accounted for. Among them are 798 grasses, 555 legumes and 889 miscellaneous items. By far the greatest number of packages received were in the Westover-Enlow collections.

Personal Items

Surgeon-General Hugh S. Cumming attended a meeting of the Health Committee of the League of Nations at Geneva, October 7 to 16, and also the sessions of the International Health Office in Paris, beginning October 17.

Commissioner Frank T. Bell of the Bureau of Fisheries, U S. Department of Commerce, was elected president of the American Fisheries Society, at its September meeting in Tulsa, Oklahoma. In attendance with Mr. Bell were R. H. Fiedler, Elmer Higgins, Ted Little and H. S. Davis, of the Bureau.

Col. Robert Birnie, U. S. Army Ordnance Corps, retired, was awarded the Ordnance Medal of Merit by the Army Ordnance Association, in recognition of his pioneer work in gun design.

Obituary

Frederick L. Ransome, economic geologist and a former president of the Washington Academy of Sciences (1918), died at his home in Pasadena, Calif., October 6, 1935. He was born at Greenwich, England, December 2, 1868. At the University of California he received the B.S. degree in 1893, the Ph.D. degree in 1896, and Phi Beta Kappa membership in 1910. From 1896 to 1897 he was assistant in mineralogy and petrography at Harvard University. In 1897 he joined the U S. Geological Survey as assistant geologist and from 1912 to 1923 was geologist in charge of the section of metalliferous deposits. During the next four years he was professor of economic geology at the University of Arizona, and from 1927 until his death he held a similar position at the California Institute of Technology.

Doctor Ransome was active in many clubs and scientific societies, including the National Academy, Geological Society of America, American Association for the Advancement of Science, American Institute of Mining and Metallurgical Engineers, and Society of Economic Geologists. He was an associate editor of *Economic Geology* and the *American Journal of Science*. His numerous publications deal chiefly with the ore deposits and geology of western mining districts.

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CHEMISTRY.—*The occurrence of the methoxyl, ethoxyl and methylene dioxide groups in substances of vegetable origin and a possible explanation of the mechanism for their formation by the plant.*[1]
C. A. Browne and Max Phillips, Bureau of Chemistry and Soils.

The alkoxyl group, particularly the methoxyl group $-OCH_3$, is found widely distributed in substances of vegetable origin. Alkoxyl groups containing a greater number of carbon atoms than that found in the ethoxyl group $-O \cdot CH_2\ CH_3$ rarely occur in substances of plant origin, and even the ethoxyl group has been found infrequently in such materials. The divalent methylene dioxide group $\left.\begin{array}{l}-O\\-O\end{array}\right\rangle CH_2$ although it is found in certain alkaloids, such as piperine, hydrastine, berberine, narcotine, and narceine, and in certain constituents of essential oils, such as in piperonal, safrol, myristicin, apiol, and dillapiol, cannot, however, be compared with the methoxyl group in its frequency of occurrence and in its wide distribution in the vegetable kingdom.

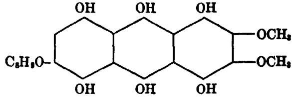
The methoxyl group may be considered as derived from a phenolic or alcoholic hydroxyl group in which the hydrogen has been replaced by a methyl group. The substance thus formed is a methyl ether. When acidic hydroxyl groups are thus substituted methyl esters are formed. It is of interest to point out in this connection that the methoxyl group does not occur in substances synthesized by the animal body.

It appears that the synthesis of the methoxyl group can be brought about by all plants from the very lowest to the very highest in evolutionary development. Thus prodigiosin, the red coloring substance produced by *Bacillus prodigiosus*, was found by Wrede and Rothhaas (19) to contain one methoxyl group. As we examine the higher

[1] Received June 3, 1935.

forms of plant life among the Thallophytes we find that the moulds, are capable of synthesizing compounds containing the methoxyl group. Thus Birkinshaw and Raistrick (1) isolated a methoxy dihydroxy toluquinone from a glucose solution on which a species of *Penicillium* belonging to the *P. spinulosum* series had grown.

Numerous compounds containing the methoxyl group have been isolated from lichens. Thus solorinic acid isolated by Zopf (20) from *Solorina crocea* was shown to contain one methoxyl group. According to Hesse (6), solorinic acid contains two methoxyl groups and is represented by this formula:



Sordinin isolated by Paterno and Crosa (10) from *Lecanora sulphurea* was found to contain one methoxyl group. Evernic acid which occurs in *Evernia prunastri* and in *Ramalina pollinaria* and chrysocetraric acid which has been isolated from *Cetraria pianastri* were both found to contain methoxyl groups (5).

With reference to the occurrence of the methoxyl group in substances synthesized by Bryophytes, mention may be made, of the work of Fischer, Schrader and Friedrich (3), who found that *Sphagnum medium* contained 0.32 per cent methoxyl, and that the coarser fibers of *Sphagnum cuspidatum* contained 0.39 per cent methoxyl. The fraction of *S. medium* which was insoluble in fuming hydrochloric acid contained 1.33 per cent methoxyl.

The occurrence of methoxyl-containing substances among the Pteridophytes has been definitely established. Linsbauer (8) has shown that plants belonging to this group, unlike Thallophytes and Bryophytes, contain lignin in their cell structure. It has been definitely shown that lignin contains methoxyl groups (12).

Among the Spermatophytes, substances containing the methoxyl group are so numerous and so widely distributed that it would be difficult indeed to find any plant whose constituents do not contain this group. Lignin which is a constituent of the woody (lignified) portions of higher plants, such as stalks, stems, cobs, hulls, leaves, trunks of trees and shrubs, contains methoxyl groups.

Whatever the physiological significance of the methoxyl group may be, it must be borne in mind that it is found in substances that may occur in almost any organ of a plant, from the root to the flower, and in plants very remote phyletically from one another. No attempt will be made here to list all the many substances isolated from Spermatophytes and known to contain the methoxyl group. Mention will be made of only a few such substances selected from a variety of families and also from different organs of the plant. The purpose of this presentation is merely to indicate the rather common occurrence of the methoxyl group in substances of plant origin.

The glucoside coniferine occurs in the cambium of coniferous woods and also in the black root of *Scorzonera hispanica* (9). This compound when hydrolyzed yields glucose and coniferyl alcohol (16),

$$C_6H_3\left\{\begin{matrix}OCH_3\\ CH{=}CH\ CH_2OH.\\ OH\end{matrix}\right.$$

Vanillin, which is the methyl ether of protocatechuic aldehyde, occurs widely distributed in the vegetable kingdom, but more especially in the fruit of *Vanilla planifolia*, a plant which is a native of the forested valleys of the eastern Mexican Andes, but is now cultivated in nearly all tropical countries.

Among the phenol ethers which have been found in many flowering plants mention may be made of the following: Methylchavicol, anethol, dimethyl ether of thymohydroquinone, eugenol, methyleugenol, isoeugenol, methylisoeugenol, asarone, apiol, dillapiol, and myristicin. These compounds have been isolated from plants belonging to the following families (14): Aristolochiaceae, Annonaceae, Myristicaceae, Lauraceae, Rosaceae, Myrtaceae, Umbelliferae, and Labiatae.

Among the class of plant alkaloids, numerous representatives containing the methoxyl group are found (4). Only a few need be mentioned in this connection, namely, berberine, papaverine, laudanosine, quinine, brucine, anhalamine, mezcaline, anhalonine, lophophorine, hydrastine, dehydrocorydaline, bulbocapnine, corytuberine, glaucine, codeine, and narcotine. The alkaloids have been found in the following natural orders of plants: Ranunculaceae, Rubiaceae, Papaveraceae, Fumariceae, Solanaceae, Leguminosae, Apocynaceae, and Compositae.

Many of the plant pigments and coloring substances contain methoxyl groups. Mention may be made of gentisin (7), which is the coloring substance of gentian roots; curcumin (2), a constituent of

several species of *Curcuma*, acacetin (11), the coloring matter of the leaves of *Robinia pseudacacia* (L.); peonidin (17), which occurs in the form of its diglucoside (peonin) in the flower of the deep violet-red peony; oenidin (18), the product of hydrolysis of oenin pigment of the black grape; and myrtillin (18), (a monoglucoside of myrtillidin), the pigment of the fruit of the bilberry (*Vaccinium myrtillus*).

SPECULATIONS CONCERNING PHYTOCHEMICAL SYNTHESIS OF METHOXYL, ETHOXYL, AND METHYLENE DIOXIDE GROUPS

Pictet (13), in a paper dealing with the genesis of the alkaloids in plants, suggests that the methoxyl group, which is met rather frequently in this class of organic compounds, and the methylene dioxide group are formed by the plant from formaldehyde. According to Pictet, the reactions which take place may be represented by the following equations:

$$ROH + CH_2O = ROCH_3 + O$$

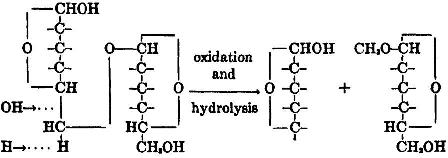
$$R\begin{matrix} \diagup OH \\ \diagdown OH \end{matrix} + CH_2O = R\begin{matrix} \diagup O \diagdown \\ \diagdown O \diagup \end{matrix}CH_2 + H_2O.$$

Robinson (15), in connection with his theory of the mechanism of the phytochemical synthesis of certain alkaloids, has adopted Pictet's conception of the formation of the methoxyl and methylene dioxide groups by the plant.

While the formaldehyde hypothesis of Pictet might explain the formation of the methoxyl group in substances synthesized by higher plants, it obviously cannot account for its presence in compounds produced by certain Thallophytes, as, for example, the fungi. Thus, for example, it canot account for the formation of methoxyl dihydroxy toluquinone by a species of *Penicillium* which grew on a solution containing *pure glucose* as its sole source of carbon. (1).

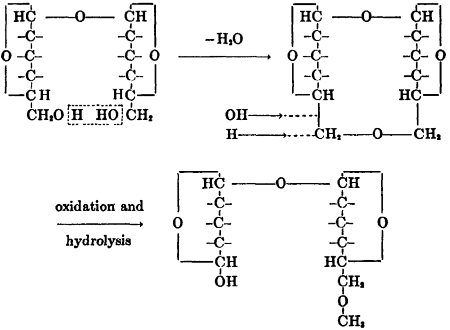
The writers wish to offer the following suggestion as a possible explanation of the mechanism involved in the formation by the plant of the methoxyl, ethoxyl, and methylene dioxide groups: These groups, it is believed, are not synthesized by the plant directly from formaldehyde by a process of methylation or methylenation, but are formed in the course of splitting up of carbohydrates by a process of hydrolysis, oxidation, reduction, and dehydration. The reactions which take place may be illustrated as follows:

FORMATION OF METHOXYL GROUP



I

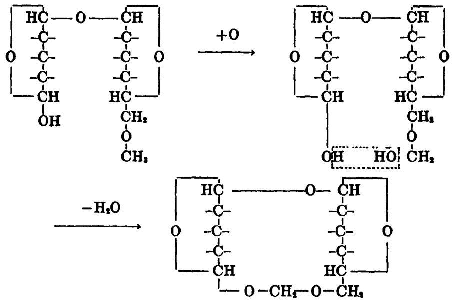
or



II

The methylene dioxide group can be considered as having been formed by a process of hydroxylation of the methyoxyl group, and the subsequent condensation with another hydroxyl group is illustrated below (III).

FORMATION OF METHYLENE DIOXIDE GROUP

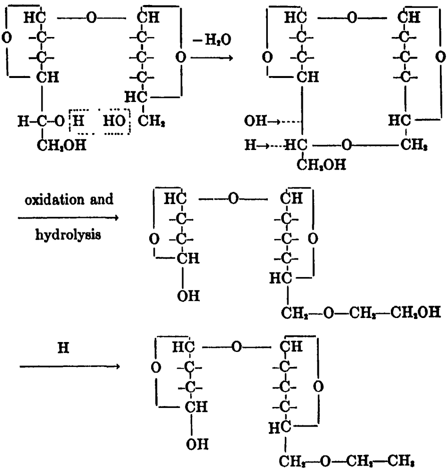


III

The ethoxyl group can be considered as having been formed by a process of splitting a carbohydrate linkage and the subsequent reduction of the hydroxy ethoxy group. This is illustrated by the following formulae (IV).

It will be observed from the formulae (IV) below that the ethoxyl group is assumed to be formed by the plant from a carbohydrate having at least one component with the labile or furanose type of structure. This may explain the rather infrequent occurrence of the ethoxyl group in the vegetable kingdom. As a corollary to this, we may possibly predict that those few plants which yield substances containing the ethoxyl group may also have sugars with the labile or furanose type of structure. In the reaction described above it is conceivable that the reduction of the $-CH_2OH$ group to a methyl group may precede oxidation and hydrolysis. This probably takes place when the plant produces methyl pentoses from hexose sugars. It is our belief that the methoxyl, ethoxyl, and methylene dioxide groups in the naturally occurring organic substances represent the original carbohydrate linkages. The presence of the methoxyl group in substances synthesized by fungi from pure sugar is readily ex-

FORMATION OF ETHOXYL GROUP



IV

plained on the assumption that the reaction proceeds as illustrated above (I and II).

Lignin, which is the most abundant methoxyl-containing constituent of higher plants, is synthesized by the plant from carbohydrates, and it is conceivable that lignin or possibly primitive lignin ("ur" lignin) may in turn be the parent substance of many of the methoxyl-containing constituents of higher plants. This is, of course, purely speculative, but it is our belief that the future development of plant chemistry will be more and more along the lines of determining from

what parent materials and in what manner the different organic chemical substances of plants are derived.

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STRATIGRAPHY.—*New formation names in the Michigan Devonian.*[1]

A. S. WARTHIN, JR., Vassar College, and G. ARTHUR COOPER, U. S. National Museum. (Communicated by ROLAND W. BROWN.)

The Traverse group of Michigan has long been known for its abundance of fine fossils, but the detailed study of these fossils has been hampered by ignorance of the stratigraphy involved. The authors, in the course of studies on the correlation of the middle

[1] Published by permission of the Secretary of the Smithsonian Institution. Received September 5, 1935.

Devonian of the interior states, have developed a fairly complete and usable subdivision of the Traverse rocks exposed in the Thunder Bay region. As the final description and correlation of these rocks will not be available for some time the authors here define the formational units recognized in order to facilitate the descriptive paleontological work now being conducted by other students in the area.

The new formations here recognized are arranged in descending order, and their division into the three stages already known is indicated.

Squaw Bay limestone, new name[2]

Brown limestone, dolomitic in some beds, containing *Styliolina* and upper Devonian goniatites. It lies below the Antrim black shale, and above the Partridge Point formation. Thickness exposed, three feet; nearby wells indicate a probable total of twelve feet. Type locality, the Squaw Bay shoreline of Partridge Point, center S line of sec. 11, T. 30 N., R. 8 E., Alpena County, Michigan. This formation probably should be excluded from the Traverse group.

THUNDER BAY STAGE, Grabau ('02, p. 192)[3]

Partridge Point formation, new name

Gray and bluish argillaceous limestones, and gray calcareous shales, containing many crinoids and blastoids. Separated from the Squaw Bay limestone by a three foot covered interval, and from the Potter Farm formation below by an interval of not more than seventy feet. Thickness exposed, fourteen feet. Type locality, eastern shore of Partridge Point, three miles south of Alpena, Michigan.

Potter Farm formation, new name

Blue to gray shales, alternating with crinoidal, sublithographic or argillaceous limestones of small lateral extent, containing a fauna characterized by the common presence of *Cylindrophyllum*. Separated from the Partridge Point formation above by a covered interval of not over seventy feet, and lies directly on the upper clay of the Norway Point formation Greatest thickness measured, thirty-six feet Type locality, the Fred Potter farm, E. half of secs. 18 and 19, and sec. 20, T. 31 N., R. 8 E., Alpena County, Michigan.

Norway Point formation, new name

Brown and gray limestones, grading upward into argillaceous limestones and calcareous clay. Several of the beds carry *Spirifer* cf. *granulosus* and *Cryphaeus boothi*. Overlain directly by the Potter Farm formation, and underlain (sometimes with slight hiatus) by the Alpena limestone. Greatest thickness measured, forty-six feet. Type locality, Norway Point dam (also known as Boom Company or Seven-mile dam), Thunder Bay River, Alpena County, Michigan.

[2] New names in this paper have been checked and found available by Miss Grace Wilmarth, U. S. Geological Survey

[3] Symbols after author's name refer to citations in the *Bibliography of North American Geology*, U. S Geol. Surv , Bulls. 746, 1923, and 823, 1931.

ALPENA LIMESTONE STAGE, Grabau ('02, p. 175)

The authors recognize Ver Wiebe's ('10, p. 185) redefinition of the limits of the Alpena limestone, with the exception of the "black Alpena" zone which is separated below as the Killians limestone. The Dock Street clay of Grabau ('02, p. 192) is a local clay facies of the upper Alpena horizon.

LONG LAKE STAGE, Grabau ('02, p. 184)

Killians limestone, new name

Dark gray to black limestone with black shale layers. Overlain by gray and brown granular beds of Alpena limestone, and underlain by gray shales and limestones of the Genshaw formation. Greatest measured thickness, twenty-three feet. Type locality, exposures along French road, one-half mile south of the Killians resort, Long Lake, Alpena County, Michigan.

Genshaw formation, new name

Four persistent thin gray limestone beds, alternating with gray calcareous shales, all containing a large species of *Atrypa* and *Gypidula romingeri*. Overlain directly by black Killians beds, and underlain by clay shales of the Ferron Point formation Measured thickness, fifty-one feet. Type locality, region around the Genshaw school, sec. 13, T. 32 N., R. 8 E., Alpena County, Michigan.

Ferron Point formation, new name

Green to bluish clays, interbedded with argillaceous limestones, all carrying an abundance of fossils. Overlain directly by the calcareous shale of the Genshaw formation and underlain by the Rockport limestone. Thickness, approximately thirty-five feet. Type locality, Rockport quarry, Rockport, Alpena County, Michigan.

ROCKPORT LIMESTONE, R. A. Smith ('16, p. 175)

BELL SHALE, Grabau ('02, p. 191)

Base of the Traverse group in Alpena region.

PALEONTOLOGY.—*Further notes on fossil larval chambers of mining bees.*[1] ROLAND W. BROWN, U. S. Geological Survey.

Since the publication of my first paper on this subject,[2] I have learned several important additional facts that merit statement and necessitate changes in the nomenclature applied to those fossils.

First, it was discovered that in 1907 some similar but more fragmentary fossils, lacking the spiral apices, were described by E. Schütze[3] as the fillings of bee chambers under the name *Anthophora*

[1] Published by permission of the Director, U. S. Geological Survey. Received July 24, 1935.

[2] BROWN, ROLAND W. Celliforma spirifer, *the fossil larval chambers of mining bees* This JOURNAL 24: 532–539, text figs 1–5. 1934.

[3] SCHÜTZE, E, in W. BRANCA and E. FRAAS. *Die Lagerungsverhältnisse Bunter Breccie an der Bahnlinie Donauwörth-Treuchtlingen und ihre Bedeutung für das Riesproblem.* K.-preuss. Akad Wiss. Abh, Heft 2: 25–26, plate (opp. p. 56), figs. 22, 23. 1907.

Podalirius)? sp. Like Dall, Schütze observed a superficial resemblance of the fossils to fillings of pholad burrows but, unlike Dall, dismissed the pholad suggestion as unacceptable and referred the fossils to fillings of chambers made by an anthophorid bee. However, in this instance as with the Wyoming and Florida fossils also, because no remains of the insects themselves were found, and because it is not conclusively proved that the fossils are related to mining bees, although the circumstantial evidence points strongly in that direction, the reference to the particular genus *Anthophora*, it seems to me, is not an especially happy one.

Second, because differences between the specimens from Wyoming and those from Florida are discernible, as was pointed out in my first paper, it will clarify matters to distinguish two species. I therefore propose that the term *Celliforma* be the generic name to include all fossil fillings of chambers purporting to have been made originally by unknown mining Hymenoptera, and I designate *Celliforma spirifer* Brown, from the Bridger formation of Wyoming, as the genotype. The specimens from the "silex beds" of the Tampa limestone of Florida may be known as *Celliforma nuda* (Dall) Brown, new combination, and Schutze's specimens, from the Oligocene of Weilheim, Germany, as *Celliforma germanica* Brown, new name.

Third, several more new references to the literature on mining Hymenoptera indicate that other observers have also noted the spiral construction used by these bees in sealing their larval chambers. Friese[4] alludes to this structure in his discussion of *Anthophora*, and Rau,[5] discussing the carpenter bee (*Xylocopa virginica*), describes the nest construction and gives an excellent illustration of the spiral sawdust seal made by that species. The use of the spiral seal by *Emphor fuscojubatus* is illustrated in many newly-made chambers exhumed on July 18 and 21, 1935, Second and T Streets N. E., Washington, D.C. Incidental to the collection of these chambers, it was observed that, 1. This species of *Emphor* selects the site for a burrow, softens the hard soil with frequent applications of jets of water imbibed from the surface of the adjacent pool, and within 30 minutes constructs an entrance turret 1 centimeter high. 2. In less than 4 days she completes the burrow from 5 to 10 centimeters deep, fashions the larval chamber, fills it with the lemon-yellow pollen from the shrubby althea (*Hibiscus syriacus*), lays an elongated, pearly white

[4] FRIESE, A. *Beiträge zur Biologie der solitären Blumenwespen (Apidae)*. Zool. Jahrb Abt. für System. Band 15: 818 ff. 1891

[5] RAU, PHIL. *Jungle bees and wasps*, pp. 244–245, fig 100. 1923.

egg *on the bottom* of the pollen mass, seals the chamber, packs the rest of the burrow with pellets derived from the turret, and closes the entrance with a smooth, saucer-shaped plug. 3. The pollen mass ferments, darkens somewhat and assumes a pasty consistency; and the larva, from the time of hatching, apparently occupies less than a week in consuming this stimulating nourishment and attaining its maximum length of about 1.5 centimeters.

Finally, the now accepted name *Melitoma* should be substituted for *Entechnia* in my former references to *Entechnia taurea*.

BOTANY.—*A new tree-fern from Trinidad.*[1] WILLIAM R. MAXON, National Museum.

The new species described herewith is one of the most interesting among the rich collections of Trinidad ferns received from the Venerable Archdeacon A. Hombersley in recent years. It is named with much pleasure in honor of its discoverer.

Hemitelia Hombersleyi Maxon, sp. nov.

Species *H. Wilsoni* affinis, sed tamen optime distinguenda, differt enim pinnis linearibus, pinnulis multo minoribus, obtusis (nec acuminato-attenuatis), et lobatis (nec pinnatifidis), lobis et serraturis parvis, venis paucis, paleis costae et venarum brunnescentibus nec albis, soris minimis, et indusiis pallide brunneis, nec albidis.

Rhizome an erect caudex about 60 cm. long and 5 cm. in diameter; scales tufted-imbricate, about 1.5 cm. long, 3 mm. broad at the lanceolate basal portion, attenuate-subulate, light brown, concolorous, the margins lightly erose-scarious. Fronds several, erect-arching, 1.5–2 m. long, the stipes short (30–40 cm. long), brown, slender, 1–1.5 cm. thick, freely beset with straight, narrowly conical, pungent spines 1–3 mm. long, paleaceous on inner face, the scales subovate, acuminate, 5–10 mm. long, mostly subfalcate, thin; blades about 1.5 m. long, 75 cm. broad at middle, broadly oblong, abruptly acuminate at apex, subbipinnate; pinnae about 18 pairs, opposite, slightly apart, linear, acuminate at apex, the two basal pairs short-stalked (5–7 mm.) and strongly deflexed, those above laxly horizontal, 30–38 cm. long, 5–7.5 cm. broad, subsessile, evenly pinnatifid almost to the costa nearly throughout, pinnate at base; costae thinly hirtellous above, glabrate beneath and bearing a few thin broad brownish appressed deciduous scales; pinnules or segments 20–25 pairs below the lobate-serrate acuminate apex, the 2 or 3 basal pairs sessile or subsessile, the others fully adnate and lightly joined by a narrow decurrent wing, more broadly so toward the apex; segments in general 2.5–2.8 cm. long, 6–10 mm. broad, oblong, obtuse or acutish, strongly falcate, subentire in basal portion, broader and pinnately lobed toward apex, the lobes oblique, obtuse, 2–2.5 mm. broad, 1–2 mm. long, varying according to fertility; costules delicate, elevated, glabrate, bearing a few thin brownish scales beneath; veins about 16 pairs, free, those of the

[1] Published by permission of the Secretary of the Smithsonian Institution. Received October 12, 1935.

Hemitelia Hombersleyi Maxon, sp. nov.—The type specimen, at two-fifths natural size.

larger lobes with 2 to 4 pairs of pinnately arranged branches, elevated, glabrate beneath, bearing occasional short setiform hairs above; sori small, 2 or 3 (4) to each group of veinlets, occupying an irregular nearly medial zone between the costa and margin; indusium a pale brown, saccate, usually bilobate or trilobate, proximal scale; receptacle globose.

Type in the U. S. National Herbarium, no. 1,231,265, collected on the "Aripo Road, via Arima, on a bank between 3 and 3½ mile posts," Trinidad, June 12, 1925, by A. Hombersley, this being the middle portion of a blade. Other material at hand consists of the apex and basal portions of a frond of the type collection; *Broadway* 6118, collected April 16, 1926, on the Blanchisseuse Road, near the 10½ mile post; *Broadway* 5913, collected Jan. 29, 1926, on the Las Lapas Road; and an entire frond with apex of caudex, collected by Mr. Hombersley (no. 208), Jan. 29, 1926, on the "Las Lapas Road, on left, about ½ mile from junction with Blanchisseuse Road, at 2000 ft. elevation."

This ample series of specimens shows no more than normal variation and indicates a species which, though allied to *H. Wilsoni* Hook.,[3] of Jamaica, Porto Rico, and Hispaniola, differs notably in size and essential characters. That species has, for example, the pinnae up to 85 cm long, oblong, 12 to 25 cm. broad, the pinnules up to 14 cm. long, 1 to 2 cm broad, long-acuminate to conspicuously attenuate at apex, and pinnatifid (rather than lobed) below that, the lobes 3 to 8 mm. long and 3 to 5 mm. broad, with 6 to 10 pairs of veins, the costae and veins bearing a few appressed *white* scales beneath, the numerous sori more than twice as large as those of *H. Hombersleyi*, and the huge indusium *whitish*, rather than pale brown.

ZOOLOGY.—*Fresh-water Ostracoda from Massachusetts.*[1] NORMA C. FURTOS, Western Reserve University. (Communicated by WALDO L. SCHMITT.)

The earliest reference to fresh-water Ostracoda in Massachusetts was a note by Haldeman in 1842 concerning a "*Cypris scabra*" taken from a small pond near Cambridge, but from the brief description given,[2] it is not possible to identify it with any known species. In 1905 Cushman reported and figured a new species, *Cyprinotus americanus*, from Nantucket, and in 1907 listed seven other species, none new, as follows: *Cypricercus passaicus* (syn. *Spirocypris passaicus*) from Wellesley; *Eucypris virens* (syn. *Cypris virens*) from Arlington; *Eucypris fuscata* (syn. *Cypris fuscata*) from Cambridge; *Eucypris reticulata* (syn. *Cypris reticulata*) from Brookline; *Cypridopsis vidua vidua* from West Cambridge, Cambridge, and Cohasset; *Cypria*

[3] Hook in Hook. & Baker, Syn. Fil 30. 1865; Maxon, Contr. U. S Nat. Herb. 17: 416 pl 18 1914.

[1] Received August 15, 1935.

[2] "Shell modioliform rough, inflated, thickly covered with bristles; colour (of the dead shell) pale livid, or corneus. Length 1½, height 1 millimeter." (Haldeman.)

(*Cypria*) *elegantula* (syn *Cypria exsculpta*) from Woods Hole and Auburndale, *Candona candida* from Arlington and Auburndale The above summarizes about everything that has been known concerning the fresh-water Ostracoda of Massachusetts That a group of Crustacea as common and abundant as this should be so consistently overlooked by aquatic biologists is most surprising

This report is based chiefly upon a series of collections taken by the author during June, July, and August of 1933 from various fresh-water pools, ponds, marshes, and rivers of Cape Cod and the Elizabeth Islands Since only remnants of the spring fauna remain by early June, the number of species obtained has in no way exhausted the possibilities of the region Six of the species recorded by Cushman do not appear in the present collection Of the fourteen that were taken, three are new species and two new varieties of known species As two, *Cypridopsis vidua vidua* (O F Müller) and *Cypria* (*Cypria*) *elegantula* (Lilljeborg), have already been reported by Cushman, they will not be further noticed in this paper Besides the collections from the Cape, material received from the United States National Museum revealed two additional species from Hampshire County

The work was done under the auspices of the Marine Biological Laboratory, Woods Hole, Mass , and the Biological Laboratory of Western Reserve University Facilities at Woods Hole were made available through the kindness of Dr M H Jacobs, the Director, and at Western Reserve University by Dr J Paul Visscher Specimens of all species described have been deposited in the United States National Museum In the case of holotypes and male paratypes, body parts are placed on permanent slides and valves in specially labelled vials

Family CYPRIDAE
Subfamily CANDOCYPRINAE
Tribe CYCLOCYPRINI
Genus CYPRIA Zenker, 1854

The genus is divided into two subgenera *Cypria* and *Physocypria*, according to the character of valve-margins In *Cypria* margin of each valve is smooth while in *Physocypria* margin of right valve is distinctly tuberculated and that of left valve smooth

Cypria (Cypria) palustera n sp Fig 1

Specific characters—Female, from the side Somewhat elongate, dorsal margin smoothly arched, ventral margin straight, height slightly less than two-thirds of length, highest just behind middle, extremities broadly rounded, the anterior broader, well developed hyaline border along an-

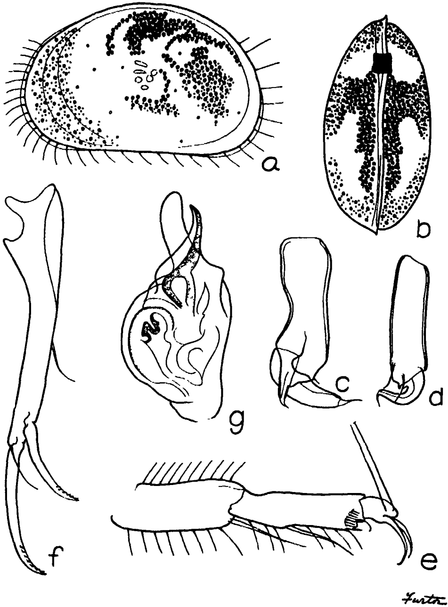

Fig. 1.—*Cypria* (*Cypria*) *palustera* new species. *a*, left valve, adult female; *b*, adult male, viewed from above, *c-d*, prehensile palps, *e*, scratch-foot, female, *f*, caudal ramus, female, *g*, penis.

terior, antero-ventral and posterior margins of left valve and along entire free margin of the right. From above: Moderately compressed, breadth slightly less than one-half of length, broadest in middle; left valve longer than right, extending clearly beyond right at each end; extremities narrowly rounded, the anterior somewhat narrower. Surface of valves smooth, with large scattered puncta, hairless except for a few slender marginal hairs. Color light brown with dark brown areas; one large diffusely pigmented area at anterior extremity, another darker dorso-lateral area behind ocular region, another diffuse area in postero-lateral region. Length 0.63, height 0.38, breadth 0.29 mm. Natatory setae of second antenna extend beyond tips of terminal claws by three times length of claws. The two short terminal setae of scratch-foot equal in length, one and one-half times longer than terminal segment. Caudal ramus only very slightly curved, ten times longer than narrowest width, dorsal margin smooth; dorsal seta about one-half length of subterminal claw, removed from claw by three times width of ramus; claws gently curved, decidedly subequal, each weakly denticulate near tip; terminal claw slightly exceeding one-half length of ramus; terminal seta one-third length of terminal claw.

Male smaller than female, otherwise similar Length 0.55 mm. Prehensile palps unequal, the larger with propodus narrowest in middle by virtue of sinuate outer margin and with distal process extending beyond outer margin of sharply geniculate moderately inflated dactylus; propodus of smaller palp elongate, cylindrical, dactylus short, slender, hook-like. Ejaculatory duct with five crowns of spines. Penis with narrow globular base and two subequal terminal lobes, the larger lobe finger-like with rounded apex, the smaller narrowed, curved distally toward larger lobe

C. opthalmica (Jurine) may be distinguished from the above species by the more gibbous form of valves when viewed from the side, by the more nearly equal length of valves when viewed from above, by the character of the brown pigmentation which occurs as very small speckles over whole of valve surface, by the ciliated dorsal margin of caudal ramus and by less geniculate dactyli of prehensile palps. The pigmentation of *C. inequivalva* Turner (1895) appears to be rather similar to *C. palustera*, but when viewed from above the left valve projects beyond the right at anterior extremity only, and caudal ramus much more sharply curved with dorsal seta lacking. *C. javana* Muller (1906) may at once be distinguished from the species from Cape Cod by the very nearly equal valves when viewed from above and by the very elongate dorsal seta on caudal ramus.

Occurrence—Cape Cod: Type locality, marsh between Barnstable Village and East Sandwich (June 9, 1933). Fresh-water side pool of Salt Marsh, West Falmouth (June 16, 1933); pond on shore of Nonamesset Island (June 22, 1933). Female holotype, U. S. Nat. Mus. No. 71409. Male paratype, U. S. Nat. Mus. No. 71410.

Cypria (Physocypria) posterotuberculata n. sp. Fig. 2

Specific characters—Female, from the side: Somewhat elongate, height greater than one-half of length, highest behind middle; ascending slope of dorsal margin gently arched, descending slope steeper; extremities broadly

rounded, the anterior narrower; ventral margin of right valve straight, that of left slightly convex; valves very nearly equal, the left somewhat longer; posterior extremity of right valve with distinct row of tubercles extending beyond margin, anterior and ventral margins of same valve appear smooth, but under high power of microscope very obscure tubercles may be seen inside these margins; submarginal zone evident along anterior margin of left valve, pore-canals obscure; entire free margin of left valve with fairly wide hyaline border, anterior and posterior margins of right valve with

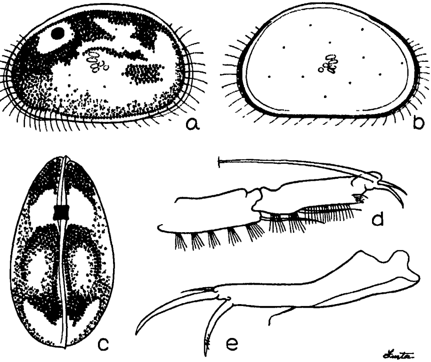

Fig. 2—*Cypria* (*Physocypria*) *posterotuberculata* new species. *a*, adult female, viewed from left, *b*, right valve, adult female; *c*, adult female, viewed from above, *d*, scratch-foot, female, *e*, caudal ramus, female

narrower border. From above: Moderately tumid, breadth exceeding one-half of length, broadest behind middle; sides evenly curved, extremities rounded, the anterior narrower; left valve enclosing the right, extending slightly beyond the right at each end. Surface of valves smooth, with a few scattered puncta and slender marginal hairs. Color light with narrow chestnut-brown band close to and parallel with all of valve margin including the dorsal, while in anterior portion of valve this band is diffusely widened to form a light brown patch which passing under eye as narrow band joins a dorso-lateral patch behind ocular region. Length 0.72, height 0.45, breadth 0.40 mm. Natatory setae of second antenna extend beyond tips of terminal claws by four times length of claws. The two short terminal setae of scratch-foot very nearly equal in length, the shorter about as long as terminal segment, the other slightly longer. Caudal ramus curved, nine and one-half

times longer than narrowest width, dorsal margin smooth; dorsal seta slightly exceeding one-half length of subterminal claw, removed from claw by somewhat less than three times width of ramus; claws decidedly subequal, gently curved, the subterminal with a comb of delicate denticles near tip, the terminal smooth, less than one-half length of ramus; terminal seta one-third length of terminal claw.

Male unknown.

Presence of distinct tubercles along posterior margin of right valve with smooth appearance of rest of margin, together with character of pigmentation serve to distinguish this species from others of the subgenus. The valves rather closely resemble *Cypria* (*Cypria*) *palustera* in proportions and coloration, but the latter is distinctly larger.

Occurrence—Cape Cod: Type locality, Palmer's Pond in Falmouth (Aug. 26, 1933). Female holotype, U. S. Nat. Mus. No. 71412. Paratypes, U. S. Nat. Mus. No. 71413

Cypria (Physocypria) globula Furtos, 1933

Cypria (*Physocypria*) *globula* Furtos, Ohio Biol. Survey Bull. **29** (Vol. **5**, No. 6): 468–469, t.16, figs. 1–9 1933.

A rather common species, occurring in ponds, marshes, small lakes and rivers from late March to October. Numerous records from Ohio and Florida as well as from Massachusetts indicate that the species is probably widely distributed over the eastern and mid-western sections of the United States.

Occurrence—Cape Cod: Lake Leman, Falmouth Hts. (June 9, 1933); Marston's Mills Pond near Hyannis (June 9, 1933); Quostinct River, Mashpee (June 9, 1933); Oyster Pond, Woods Hole (June 12, 1933); marsh near Sandwich (June 15, 1933); Oyster Pond, Falmouth (Aug. 26, 1934).

Genus Cyclocypris Brady & Norman, 1889

Cyclocypris forbesi Sharpe, 1897 Fig. 3

Cyclocypris forbesi Sharpe, Bull. Ill. State Lab. Nat. Hist. **4**: 432, 433, pl. 41, figs. 1–7. 1897.

Specific characters—*Male*, from the side: Sub-ovoid, height equal to two-thirds of length, highest behind middle; dorsal margin rather boldly arched with descending slope steeper than ascending slope; extremities broadly rounded, the anterior narrower; ventral margin slightly convex; pore-canal zone rather broad along free margin of right valve, the canals slender; pore-canal zone very narrow along margin of left valve, the canals obscure; right valve with narrow hyaline border along anterior and postero-ventral margins; left valve with similar border along postero-ventral margin while border along anterior margin is so much narrower that it is visible only under higher powers of microscope; pore-canal zone of each valve quite dark, longer canals each ending in a papilla bearing a slender marginal hair. From above: Moderately tumid, sides evenly curved, breadth three-fifths of length, broadest somewhat behind middle; right valve projecting beyond left at each end; anterior extremity somewhat pointed, the posterior nar-

rowly rounded. Surface with very sparsely scattered, but well defined dark brown tubercles, each bearing a slender hair; the tubercles particularly evident projecting beyond sides of valves when viewed from above. Entire surface with exception of small ocular areas delicately speckled with

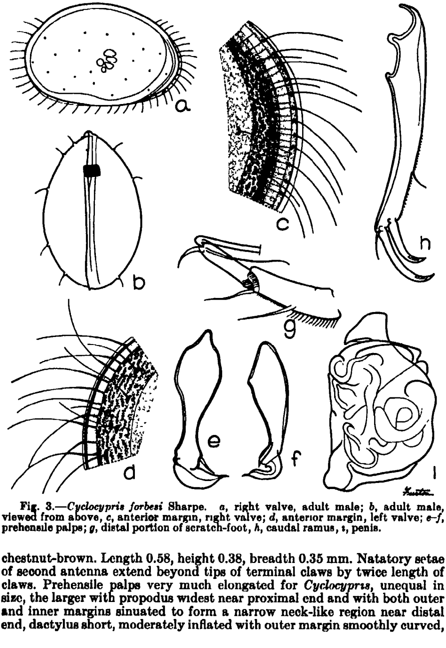

Fig. 3.—*Cyclocypris forbesi* Sharpe. *a*, right valve, adult male; *b*, adult male, viewed from above, *c*, anterior margin, right valve; *d*, anterior margin, left valve; *e–f*, prehensile palps; *g*, distal portion of scratch-foot, *h*, caudal ramus, *i*, penis.

chestnut-brown. Length 0.58, height 0.38, breadth 0.35 mm. Natatory setae of second antenna extend beyond tips of terminal claws by twice length of claws. Prehensile palps very much elongated for *Cyclocypris*, unequal in size, the larger with propodus widest near proximal end and with both outer and inner margins sinuated to form a narrow neck-like region near distal end, dactylus short, moderately inflated with outer margin smoothly curved,

inner margin approximately straight; propodus of smaller palp broadest near proximal end, outer margin convex, inner sinuated, dactylus short, narrow, hook-like. Terminal segment of scratch-foot four times longer than wide; the shortest terminal seta evenly curved, one-half length of segment. Caudal ramus gently curved, ten and one-half times longer than narrowest width, distal half of dorsal margin delicately ciliated; dorsal seta slightly greater than one-third length of subterminal claw, removed from claw by two and one-third times width of ramus; claws subequal, sharply curved at tips, weakly pectinate, terminal claw one-third length of ramus; terminal seta about one-third length of terminal claw. Ejaculatory duct quite small, with crowns of spines surrounding openings easily visible, the others quite obscure. Penis roughly quadrangular with a beak-like terminal lobe.

Occurrence—Cape Cod: Many males were taken from Weak's Pond in Falmouth (June 19, 1933). Otherwise known from Illinois.

Cyclocypris cruciata n. sp. Fig. 4

Specific characters—Male, from the side: Stout, gibbous, height slightly exceeding one-half of length, highest somewhat behind middle; left valve longer and higher than right; ascending slope of dorsal margin straight in left valve, gently arched in the right; apex of right valve broadly rounded, that of the left narrower; descending slope of dorsal margin boldly arched in each valve; extremities broadly rounded, the anterior clearly narrower. Anterior margin of right valve with a rather conspicuous hyaline flange composed of two layers of approximately equal width, an outer reddish brown segmentally arranged layer with scalloped border and an inner more hyaline layer. The flange originates near postero-dorsal angle of anterior margin, extending to beginning of ventral margin where it ends abruptly. Anterior margin of left valve with an ordinary hyaline border comparable to inner layer of right valve-flange, does not end abruptly and without any evidence of curious scalloped structure characteristic of right valve. Submarginal line rather widely removed from anterior margin of left valve, pore-canals slender, each bearing a marginal hair; submarginal zone of right valve about one-half as wide; each valve with hyaline border lacking along ventral and posterior margins. From above: Tumid, ovoid, sides evenly curved, breadth equal to height, broadest slightly behind middle; anterior extremity pointed, the posterior broadly rounded; left valve projecting slightly beyond right at each end. Surface of valves smooth with a few scattered hairs near margins. Color light with dark blue bands so arranged that from above they appear as a large X crossing behind ocular region, while from the side the pigmentation extends over all of surface except ocular region and a larger dorso-lateral area behind the eye. Length 0.53, height 0.37, breadth 0.37 mm. Natatory setae of second antenna extend beyond tips of terminal claws by not quite length of claws Prehensile palps small, propodi rather short, roughly cylindrical, approximately equal in size; dactyli short, the one slender, hook-like, the other moderately inflated with outer margin smoothly curved. Terminal segment of scratch-foot three times longer than wide, the short terminal seta gently curved, one-third length of segment. Caudal ramus straight, twelve and one-half times longer than narrowest width, dorsal margin smooth; dorsal seta absent, but with a papilla marking place where seta ordinarily is found in the genus; claws curved, very slightly subequal, weakly denticulate near tips; terminal seta well developed, almost three-fourths length of terminal claw.

Ejaculatory duct with five crowns of spines. Penis globular with two subequal terminal lobes, the larger triangular with pointed apex, the other more slender, smoothly rounded distally and curved toward apex of larger lobe.

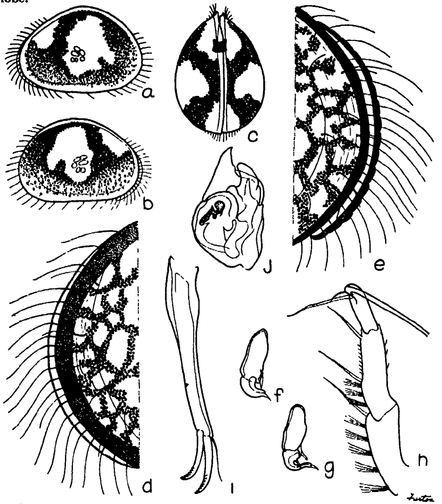

Fig 4—*Cyclocypris cruciata* new species *a*, left valve, adult male, *b*, right valve, adult male; *c*, adult male, viewed from above, *d*, anterior extremity, left valve; *e*, anterior extremity, right valve; *f–g*, prehensile palps; *h*, scratch-foot, male; *i*, caudal ramus, male; *j*, penis.

Female unknown.

Occurrence—Cape Cod: Type locality, Marston's Mills Pond near Hyannis (June 9, 1933) where several males were taken. An empty shell was taken from a marsh between Barnstable Village and East Sandwich on the same day. Otherwise known from Lake Chautauqua, New York, where several males were collected by the author Aug. 12, 1932. Male holotype. U. S. Nat. Mus. No. 71416. Paratypes, U. S. Nat. Mus. No. 71417.

Cyclocypris ampla Furtos, 1933

Cyclocypris ampla Furtos, Ohio Biol. Survey Bull. **29.** (Vol. 5, No. 6): 461–462, t. 14, figs. 1–7. 1933.

This is the largest of the known species of *Cyclocypris* occurring in North America. Length 0.7–0.8 mm. Readily identified by its size, very tumid valves and glossy chestnut-brown color which on closer examination appears as densely situated brown speckles on yellow-brown background.

Occurrence—Cape Cod: Deep Pond at Hatchville (June 23, 1933). Otherwise known from Ohio and Lake Chautauqua in New York.

Cyclocypris laevis (O F. Müller, 1776)

Cypris laevis (part.) O. F. Müller, Zool Dan. Prodr.: 198. 1776.

Cyclocypris laevis Sars, Crust. Norway **9**: 93–94, t 43, fig 2, 1928.

non *Cyclocypris laevis* Sharpe, Proc. U. S. Nat. Mus. **35**: 408–410, t. 50, fig. 5; t. 54, figs. 5–7. 1908.

A widely distributed form often confused with *C. ovum* (Jurine) and *C. serena* (Koch). The specimens taken from Massachusetts agree quite well with figures and description given by Sars (1928). Characterized by small size (0.5 mm. in length for female) more gibbous than *C. ovum* when viewed from the side, surface of valves delicately speckled with brown. Viewed from above, anterior extremity pointed, the posterior broadly rounded, greatest breadth distinctly behind middle

Occurrence—Hampshire County. Otherwise known from Europe and Central Asia.

Tribe CANDONINI

Genus CANDONA Baird, 1842

Candona caudata Kaufmann var. **ciliata** n. var. Fig. 5

Specific characters—Female, from the side: Elongate-reniform, height about one-half of length, highest behind middle; ascending slope of dorsal margin gently arched to rounded apex, descending slope steep, producing truncate appearance to posterior portion of right valve; anterior extremity broadly rounded, posterior extremity narrower; ventral margin sinuate; infero-posteal region of left valve with ventral sinuation producing a somewhat projecting postero-ventral prominence, this region of right valve without such prominence; submarginal line removed from entire free margin, more widely removed along posterior margin, pore-canals each bearing a slender marginal hair. From above: Moderately compressed, sides rather unevenly curved, breadth somewhat less than one-half of length, broadest behind middle; anterior extremity pointed, the posterior narrowly rounded; left valve projecting beyond right at each end. Surface of valves with a few small scattered tubercles, those near extremities bearing slender hairs. Length 0.93, height 0.48, breadth 0.41 mm. Medial-distal seta of penultimate mandibular palp-segment smooth. Penultimate segment of scratch-foot divided, shortest terminal seta pectinate, three times length of terminal segment. Caudal ramus gently curved, thirteen times longer than narrowest

width, distal half of dorsal margin ciliated; dorsal seta three-fourths length of subterminal claw, removed from claw by three times width of ramus; claws subequal, gently curved, delicately pectinate, the terminal slightly greater than one-third length of ramus; terminal seta one-fourth length of

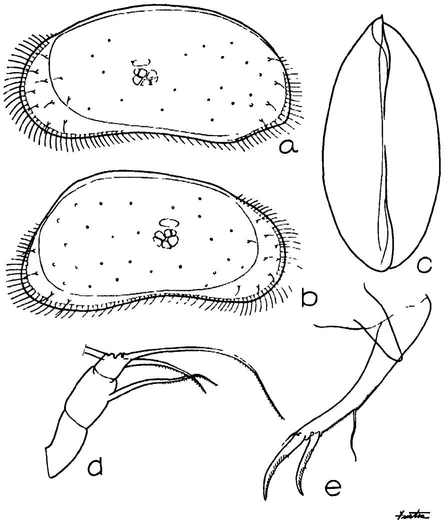

Fig 5.—*Candona caudata* var *ciliata* new variety. *a*, left valve, adult female, *b*, right valve, female; *c*, adult female, viewed from above; *d*, distal portion of scratch-foot; *e*, caudal ramus and genital lobe

terminal claw. Genital lobes well developed, each with a long finger-like posterior protuberance.

Male unknown in adult condition. Two immature specimens with testes and copulatory organs partially developed were present in the collection from Cape Cod.

This is a smaller stouter variety of the European species. *Candona caudata* as described by Kaufmann (1900) and Sars (1928) differs from the above species in the fact that right valve has some indication of postero-ventral prominence and that dorsal margin of caudal ramus is quite smooth. In other respects the North American form closely resembles that of Europe.

The species should not be confused with *Candona intermedia* Furtos (1933) which is also characterized by a similar postero-ventral prominence of left valve. The latter form is much larger (1.7 mm. in length for female), posterior extremity of valves more elongated when viewed from the side and shortest distal seta of scratch-foot four times longer than terminal segment.

Occurrence—Cape Cod: Marsh between Barnstable Village and East Sandwich (June 9, 1933). Female holotype, U. S. Nat. Mus. No. 71420.

Candona annae Méhes var. **septentrionalis** n. var. Fig. 6

Specific characters—*Male*, from the side: Elongated, height equal to one-half of length, highest behind middle; ascending slope of dorsal margin gently curved, apex broadly rounded, descending slope boldly arched; ventral margin sinuate; extremities broadly rounded, the anterior narrower; submarginal zone not apparent. From above: Compressed, elliptical, breadth somewhat greater than one-third of length, broadest behind middle; left valve enclosing right, extending beyond right at each end; extremities pointed, the anterior clearly narrower Surface of valves smooth with a few marginal hairs. Length 0 92, height 0 46, breadth 0.34 mm. Medial-distal seta of penultimate mandibular palp-segment smooth. Prehensile palps unequal in size, weakly falciform, outer margin of propodi sinuate, dactyli rather short, that of larger palp inflated along outer margin. Penultimate segment of scratch-foot undivided, the shortest terminal seta curved, about one and one-half times length of terminal segment. Caudal ramus straight, fourteen times longer than narrowest width, dorsal margin smooth; dorsal seta approximately two-fifths length of subterminal claw, removed from claw by two and one-half times width of ramus, claws very slender, curved, delicately pectinate, subequal, the terminal one-half length of ramus; terminal seta one-fifth length of terminal claw. Ejaculatory duct with five crowns of spines. Penis triangular with rounded apex, quadrangular lateral lobe and rounded terminal lobe only slightly narrower than apex of base, but projecting considerably beyond the latter.

Female unknown.

The above species differs from *Candona annae* Méhes (1913) in a few minor details. Viewed from above, the latter species is somewhat more pointed anteriorly and left valve projects to a lesser extent beyond the right at posterior end. Viewed from the side proportions and valve-surface of the two forms are identical, but *Candona annae* has in addition a rather definite submarginal zone. Appendages and copulatory organs of the two closely correspond, but terminal seta of caudal ramus is definitely longer, stronger in the specimen from Massachusetts. *Candona annae* was first reported by Méhes for South America with terminal seta of caudal ramus absent. The

author has recently described the species for Florida with this seta very delicate, almost obscure. Presence of a well developed terminal seta, together with absence of submarginal zone on valves constitute the chief characters of the new variety.

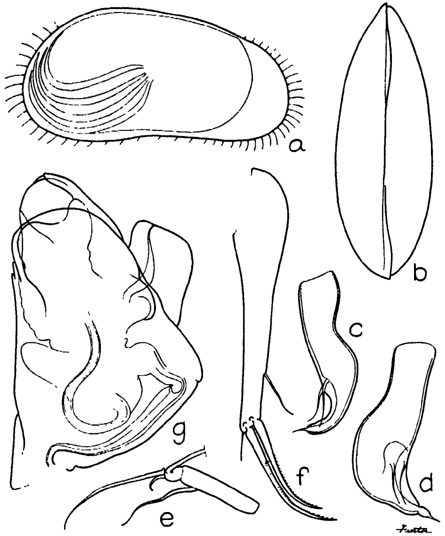

Fig 6 — *Candona annae* var *septentrionalis* new variety *a*, right valve, adult male; *b*, adult male, viewed from above; *c–d*, prehensile palps; *e*, distal portion of scratch-foot; *f*, caudal ramus, male, *g*, penis

Candona annae should not be confused with *Candona elliptica* Furtos (1933). Male of the latter species is narrower in posterior region of valves when viewed from the side, marginal hairs considerably shorter. Viewed from above, *Candona elliptica* is broadest in middle whereas *Candona annae*

is broadest behind middle. Terminal lobe of penis projects only slightly beyond apex of base in *Candona elliptica* while in *Candona annae* this lobe is very clearly longer.

Occurrence—Cape Cod: Woods Hole in field drainage-ditch (June 12, 1933). Male holotype, U. S. Nat. Mus. No. 71421.

Candona elliptica Furtos, 1933

Candona elliptica Furtos, Ohio Biol. Survey Bull. **29**, (Vol. **5**, No. 6): 482–483, t. 12, figs. 1–7. 1933.

An elongated, low-arched, very compressed *Candona* which may readily be confused with *Candona annae* as pointed out in the discussion of the latter species. Length 0.90–0.94 mm.

Occurrence— Cape Cod: Quostinet River at Mashpee where a single male was taken. Otherwise known from Lake Erie region of Ohio

Candona punctata Furtos, 1933

Candona punctata Furtos, Ohio Biol. Survey Bull. **29**, (Vol. **5**, No. 6): 485–486, t. 13, figs. 2–8. 1933

Easily recognized by stout gibbous truncate form when seen from the side, and by tumid spindle-shape with pointed extremities when seen from above. Surface of valves pitted and covered with long hairs Length of female 0.85–0.90 mm Male somewhat larger.

Occurrence—Cape Cod: Marsh between Barnstable Village and East Sandwich (June 9, 1933), woodland pools on Nonamesset Island (June 22, 1933). Otherwise known from Ohio.

Candona decora Furtos, 1933

Candona decora Furtos, Ohio Biol. Survey Bull. **29**, (Vol. **5**, No. 6): 477–478, t. 8, figs. 4, 5; t. 9, figs. 21, 22; t. 11, figs. 5, 6. 1933.

Large forms, posterior portion of female valves truncate but with dorsal part of posterior margin somewhat swollen, posterior portion of male valves broadly rounded. Surface of valves appear obscurely reticulate, particularly near posterior extremity. Penis characteristic with conical lateral lobe and small terminal lobe projecting beyond apex of base. Length of female 1.1–1.3 mm. Male slightly larger

Occurrence—Hampshire County. Otherwise known from Ohio where the species is particularly abundant in temporary leafy pools of Beech-Maple forests near Cleveland. Occasionally in ponds and lakes. Spring.

Subfamily CYPRINAE

Genus Cypricercus Sars, 1895

Cypricercus splendida Furtos, 1933

Cypris (*Cypricerus*) *splendida* Furtos, Ohio Biol. Survey, Bull. 29 (Vol. **5**, No. 6). 455–456, t. 3, figs. 1–7. 1933.

Large, brightly banded forms readily confused with *Eucypris fuscata* (Jurine) from which it may be distinguished by relatively hairier valve-surface, more numerous surface tubercles and the constant presence of males. Length of female amounting to 1.75 mm. Male slightly smaller, characterized by testis forming spiral coil in anterior portion of valve-chamber. The species should not be confused with *Cypricercus passaicus* (Sharpe, 1903) which according to Sharpe's figures is a blunter form with valves less attenuated posteriorly when viewed from the side, nor with the smaller, more gibbous *Cypricercus tincta* Furtos (1933).

Occurrence—Nonamesset Island in a small pond (June 22, 1933). Otherwise known from Ohio.

Family DARWINULIDAE

Genus Darwinula Brady & Norman, 1889

Darwinula stevensoni (Brady & Robertson, 1870)

Darwinula improvisa Turner, Rept. Geol. Nat Hist. Survey Minn., Ser. 2, Zool.: 336, t. 81, figs. 1–3, 13. 1895.

Darwinula aurea, G. W. Müller, Das Tierreich **31**: 240. 1912.

Several specimens of this widely distributed species were taken from Massachusetts. The form is particular interesting in that eggs are not laid, but young reared in posterior valve-chamber of female. A gravid female with young well advanced has been deposited in the Museum.

Occurrence—Cape Cod: Marsh between Barnstable Village and East Sandwich, Lake Leman at Falmouth Heights (both of June 6, 1933). Otherwise known from Ohio, Georgia, Europe, and Asia Minor.

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CONCHOLOGY.—*Three new land shells from the southern United States.*[1]

JOSEPH P. E. MORRISON, U. S. National Museum. (Communicated by PAUL BARTSCH.)

While overhauling the minute land shells of eastern North America in the collection of the United States National Museum, the writer discovered the following new species.

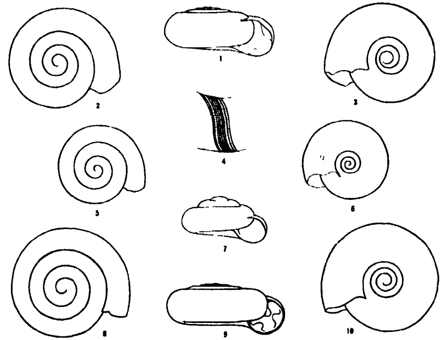
Pseudopunctum, new section

Sculpture as in *Punctum* s s., but shell is furnished with a basal lamella just within the aperture. From its appearance in the material examined, this lamella is apparently absorbed on its inner end and formed on the outer, as the shell grows; specimens of all sizes examined showing it about the same distance within the aperture, and not repeated.

Type of section: *Punctum* (*Pseudopunctum*) *smithi*, described below.

Punctum (Pseudopunctum) Smithi, n. sp Figs. 4–7

Shell minute, depressed as much as in *P. blandianum*, but with each whorl more flattened (oval in cross-section), which gives the entire shell a lower



Figs. 1–3. *Paravitrea roundyi*, n sp. Holotype. Fig. 4. *Punctum* (*Pseudopunctum*) *smithi*, n. sp. Sculpture of body whorl. Figs. 5–7. *Punctum* (*Pseudopunctum*) *smithi*, n. sp. Holotype. Figs. 8–10. *Pilsbryna tridens*, n. sp Holotype.

[1] Published by permission of the Secretary of the Smithsonian Institution. Received September 24, 1935.

appearance, even when height and diameter are practically identical. Whorls 4¼ (maximum); later whorls with major growth riblets not prominent, and interspaces with 1–3 minor growth ridges; spiral lines of equal prominence; the two producing the characteristic beaded sculpture. Umbilicus about three times in major diameter of shell. Aperture wider than high, with simple, sharp lip. Basal lamella about one-fourth the height of aperture, not on a callous; lamella is about four times as long as wide, twice as long as high, sloping gradually both towards and away from the peristome. In fresh (translucent) shells, the spindle-shaped basal outline of the lamella is evident in umbilical view, close to the aperture margin.

The type, U. S. N. M. Cat. No. 318466a, was collected by H. H. Smith near Huntsville, Madison County, Alabama (Coll. No. 367). It measures: Height, 0.62 mm.; maj. diam., 1.15 mm.; min. diam., 1.0 mm. Height of aperture, 0.32 mm.; diam. of aperture, 0.37 mm ; umb. diam., 0.43 mm.

I have also seen specimens from Gurley, Madison County, and Wadley, Randolph County, Alabama, also collected by H H. Smith, and a single specimen in the Lea Collection from "Kentucky, near Cincinnati, Ohio."

This species has a lighter color with a slight greenish cast, instead of brownish as in *Punctum* s s , although the sculpture is essentially the same. One glance at the translucent base or into the aperture, and it can not be misunderstood.

Paravitrea roundyi, n sp. Figs. 1–3

Shell minute, depressed, smooth, with a channeled suture. Whorls (4 in type) slightly flattened above the periphery and well rounded below. Aperture as wide as high; constricted by teeth and the curve of the penultimate whorl to a tricorn shape. There are two low, callous-like teeth in a radial row, one basal and one palatal, above the periphery. Umbilicus widely open, contained about 2¼ times in the major diameter of the shell.

The type, U. S. N M. Cat. No 365154, was collected by P. V. Roundy near Dewey, Washington County, Oklahoma. It measures: Height, 0.7 mm.; maj. diam., 1 5 mm.; min. diam., 1 35 mm.; height of aperture, 0.5 mm.; diam. of aperture, 0.5 mm.; umb. diam., 0.6 mm.

I have seen specimens also from Hickory Creek Oklahoma, collected by P. V. Roundy, and from Cleveland County, Oklahoma, collected by R. Frank Hedges.

This species may be easily confused with *Hawaiia minuscula* from the same region, unless the height of the spire or the size of the nuclear whorls are carefully compared, or the teeth within the aperture are seen.

Pilsbryna tridens, n. sp. Figs. 8–10

Shell minute, umbilicate; whorls (4 in type) flattened above, well rounded below, regularly increasing in diameter; suture very shallow; growth lines not prominent, irregularly spaced. Umbilicus contained almost 3 times in major diameter of shell. The color is whitish (translucent) in the specimens seen. Aperture reniform, greatly constricted by the three teeth just within the simple sharp lip. The mid-parietal lamella is scalloped as in *P. castanea* and extends as far as can be seen into the aperture; the basal and palatal

teeth are blunt, very prominent, in a radial row (as in *Paravitrea*), with the palatal directly opposite the parietal lamella.

The type, U. S. N. M. Cat. No. 359722, was collected by P. V. Roundy near Strawn, Palo Pinto County, Texas. It measures: Height, 0.67 mm.; maj. diam., 1.6 mm.; min. diam., 1 47 mm. Height of aperture, 0.5 mm.; diam. of aperture, 0.5 mm.; umb. diam., 0.57 mm.

I have also seen specimens from Cleveland County, Oklahoma, collected by R. Frank Hedges.

This species may be easily distinguished from others of the genus by the presence of a tooth on the palatal wall. Discovery of *Pilsbryna* in the Ozark region, shows that the group more nearly parallels *Paravitrea* in distribution.

ENTOMOLOGY.—*New ichneumon-flies.*[1] R. A. CUSHMAN, Bureau of Entomology and Plant Quarantine. (Communicated by HAROLD MORRISON.)

This paper consists of the descriptions of one new genus and thirteen new species, and a few generic transfers and notes on synonymy, together with a key to the North American species of the genus *Neliopisthus*.

The descriptions of new species are published at this time to make the names available for use in important economic papers on the host insects.

Most of the material on which the discussion is based was received from various laboratories of the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, type material of eight of the new species being reared at the Gipsy Moth Laboratory of that Bureau at Melrose Highlands, Mass., and that of another at laboratories devoted to the investigation of the oriental fruit moth. Types of four of the new species were received from State colleges and experiment stations, while material of the old species discussed was received largely from the Bureau of Entomology and Plant Quarantine.

Phaeogenes epinotiae, n. sp.

Very variable with respect to the color of the abdomen, which may range from piceous black with only the narrow apices of tergites 2–4 reddish, to black at base and apex with tergites 2–4 entirely ferruginous. The holotype is, in this respect, intermediate between the two extremes.

Female.—Length 4 mm., antennae 2.25 mm.

Head twice as broad as thick; temples strongly convex and nearly as long antero-posteriorly as short diameter of eye; occiput rather deeply concave; ocellar triangle weakly transverse, postocellar and ocellocular lines subequal, ocelli small; vertex, frons, and face opaque coriaceous with shallow punctures; eyes parallel above, weakly divergent below antennae and about their long diameter apart; antennae situated opposite lower fourth of eye;

[1] Received August 22, 1935.

face more than twice as broad as long, medially slightly elevated; clypeus much more than twice as broad as long, polished, with a single row of punctures near apex; malar space two-thirds as long as basal width of mandible; mandible long parallel-sided, upper tooth the longer; antennae slightly more than half as long as body, 22-jointed, thickened toward apex, basal joints of flagellum subequal in length and each much less than twice as long as thick. *Thorax* hardly as broad as head, slightly depressed, nearly twice as long as deep; mesoscutum densely punctate, scutellum sparsely so and shining; mesopleurum opaque, punctate, speculum polished; propodeum very densely rugulose opaque; areola coriaceous, about as broad as long, only obscurely closed posteriorly, petiolar area shallowly concave; radius slightly behind middle of stigma; nervellus perpendicular, broken far below middle; legs rather slender; hind coxa usually mutic, rarely with a very small carina. *Abdomen* narrower than thorax, granularly opaque; second tergite fully as long as first and as long as broad, gastrocoeli strongly transverse, situated nearly at basal third of tergite; ovipositor sheath slightly exserted.

Black; abdomen with tergites 2–4 narrowly reddish at apex or more extensively reddish, sometimes entirely so; clypeus and mandibles reddish piceous; antennae fusco-ferruginous, darker above, scape and pedicel piceous; wings hyaline, venation brown, radices white, tegulae piceous; legs piceous, coxae darker; apical joints of trochanters, tibiae, and tarsi more ferruginous.

Male.—Face and clypeus relatively narrower than in female; malar space shorter; antennae 23–25-jointed, fully three-fourths as long as body, tapering toward apex; abdomen narrower, barely fusiform.

Clypeus and mandibles white, clypeus sometimes fuscous in apical middle; face entirely black to entirely white, frequently white at sides and sometimes also in middle; legs more reddish, especially the front and middle legs; abdomen black with at most the narrow apical margins of middle tergites piceous.

Hosts.—*Epinotia nanana* Treitschke; *Recurvaria piceaella* Kearfott.

Type locality.—Georgetown, Maine.

Type.—No. 51056, U S National Museum

Eleven females and 12 males received from the Gipsy Moth Laboratory, all but two reared from *Epinotia nanana*, the two from *Recurvaria piceaella*. All bear Gipsy Moth Laboratory No. 9590. Other localities, all in Maine, are Bristol, Harpswell, and Boothbay.

Diadromus subtilicornis (Gravenhorst)

Synonym.—*Herpestomus plutellae* Ashmead (new synonymy)

Discovery that Ashmead's species is a *Diadromus* and not an *Herpestomus* led me to compare it with *subtilicornis*, a species commonly recorded as a parasite of *Plutella maculipennis* in Europe. They are undoubtedly the same.

Chrysopoctonus chrysopae (Ashmead) Cushman

Synonym.—*Chrysopoctonus atriceps* (Ashmead) Cushman (new synonymy).

Because of the marked color antigeny I did not suspect the synonymy of *atriceps* when I transferred both names to my genus *Chrysopoctonus*.[2] The

[2] CUSHMAN. Proc U. S. Nat. Mus 55: 518–520. 1919

male (*chrysopae*) is largely black, while the female (*atriceps*) is uniformly ferruginous with the head black. The fact that they are the sexes of the same species is indicated by a series of 410 specimens (326 females and 84 males) collected in traps in connection with the Mediterranean fruit fly survey in Florida some years ago.

Aenoplex betulaecola Ashmead

Synonym.—Aeneoplex plesiotypus Cushman (new synonymy).

The characters employed to distinguish *plesiotypus* from *betulaecola* in the original description of the former have been found, on examination of many additional specimens reared principally from the oriental fruit worm, *Grapholitha molesta* (Busck), to be variable within the species.

Aenoplex molestae (Uchida), n. comb.

Hemiteles (*Isadelphus*) *molestae* Uchida, Insecta Matsumurana, **7**: 158, fig. 2. 1933.

This Japanese parasite of *Grapholitha molesta* (Busck) is very similar to the American parasite of the same host, *Aenoplex betulaecola* Ashmead, but is easily distinguished by its dorsally more shining thorax and abdomen, and the distinct white base of the hind tibia.

Genus APTESIS Foerster

Aptesis Foerster, Wieg. Archiv. **17**: 34; 1850, Verh. nat. Ver. preuss. Rheinland **25**: 173, 1868; Schmiedeknecht, Opusc. Ichn., fasc. **8**: 650, 1905. Genotype, *Pezomachus sudeticus* (*Grav.*), by designation of Viereck, 1914.

Pezoporus Ashmead, Proc. U. S. Nat. Mus. **23**: 27; 1900 (not Foerster). Genotype, *Pezomachus nigrocinctus* (Grav.), by designation of Ashmead. Monobasic.

Microcryptus Thomson, Opusc. Ent., fac. **5**: 520; 1870, fasc. **9**: 850, 1883; Schmiedeknecht, Opusc. Ichn., fasc. **8**: 607, 1905. Genotype, *Cryptus erythrinus* Grav. Monobasic.

At the time of his original description of *Aptesis*, a genus of brachypterous females, Foerster referred to it, among other species, *sudeticus* (Grav.) and *nigrocinctus* (Grav.). In 1868, in his key to his family Phygadeuontoidae, he erected four new genera, including *Pezoporus*, for brachypterous species without indicating what species he intended to place in them. At the same time he maintained *Aptesis* in its original position in the Pezomachoidae. His notebooks give no further information as to the nature of the new genera, but it seems probable that he intended to divide *Aptesis* into several genera based on differences in the extent of venation in the wings.

In 1900 Ashmead transferred *nigrocinctus* (Grav.) to *Pezoporus*, designating it as the type of that genus, and placing it in the genus as a result of

his own reversal of the characters employed by Foerster to distinguish *Pezoporus* and *Stibeutes*. As a matter of fact, in Foerster's key the species runs to *Stibeutes*, and can not rightfully serve as type of *Pezoporus* Foerster.

Schmiedeknecht (1905) treats *Aptesis* as a subgenus of *Microcryptus* Thomson, ignoring the priority of *Aptesis*. The genotype of *Aptesis* is unknown to me, but there appears to be no doubt that it is congeneric with the fully-winged type of *Microcryptus*, as *nigrocinctus* certainly is.

The only described North American species heretofore assigned to *Aptesis* is *Cryptus micropterus* Say, renamed *pterigia* by Bradley because of preoccupation of Say's name. The fully-winged male of this species, reared with females from cocoons of *Neodiprion* sp. at Lincoln, Maine, is identical with a male identified by G. Stuart Walley as *Phaeogenes indistinctus* Provancher upon comparison with the type of that species The synonymy, therefore, is as follows:

Aptesis indistincta (Prov.), n. comb.

Cryptus micropterus Say, Boston Journ. Nat. Hist. 1: 238, 1935 (Leconte ed., vol. 2, p. 694), female, not *Aptesis microptera* (Gravenhorst). New synonymy.

Brachypterus micropterus Walsh, Can. Ent 2: 11, 1869.

Phaeogenes indistinctus Provancher, Add. Faune Ent. Can Hym., p. 43, 1886, male.

Aptesis micropterus Cresson, Syn. and Cat. N. Amer Hym., p. 199, 1887.

Aptesis pterigia Bradley, Bul. Brooklyn Ent. Soc 13: 100, 1918, female. New synonymy.

The following North American species with fully-winged females belong to *Aptesis* in this broader sense:

(Cryptus) Aptesis alacris (Cresson). New combination.
(Cryptus) Aptesis occidentalis (Provancher). New combination.
(Phygadeuon) Aptesis tegularis (Provancher) New combination.
(Cryptus) Aptesis brevicauda (Ashmead). New combination.

The following North American species, formerly placed by me in *Microcryptus*, appears better placed in *Chaeretymma*, where it is very closely allied to *parvula* (Gravenhorst) and *pleuralis* (Thomson): **(Cryptus) Chaeretymma osculata** (Prov.) (new combination.)

The new species described below is of the *Microcryptus* type.

Aptesis ferruginea, n. sp.

Female.—Length 8 mm., antennae 4 mm.

Head in dorsal view about twice as broad as thick; occiput shallowly concave; temples rather weakly convex and moderately sloping; vertex and temples sparsely, shallowly punctate, shining; frons laterally opaque, sha-

greened, medially shining and punctate; ocelli their diameter apart and a little farther removed from eyes; head in front view roundly subquadrate, the mouth very wide; eyes distinctly divergent below; antennae inserted not far above lower tangent of eyes; face opaque, shagreened and coarsely, closely punctate with a sparsely punctate median rounded elevation; clypeus nearly three times as broad as long, with a few coarse punctures medially, its apical margin thin and very broadly truncate, labrum exposed, broadly rounded; mandibles long and stout, lower tooth distinctly the longer; palpi slender; antennae stout, scape obliquely truncate, flagellum thickened toward apex and slightly flattened below, first joint hardly as long as second and hardly a half longer than thick, joints from sixth to those near apex transverse. *Thorax* flattened above and below, subopaque except mesoscutum, scutellum, and speculum, which are shining; pronotum irregularly rugose in impression; mesoscutum sparsely punctate, notauli shortly distinct basally; scutellum polished, with a few punctures; mesopleurum striato-punctate, sternauli deep but incomplete; propodeum precipitous behind, horizontal and vertical faces about equal in length, apical carina of nearly uniform strength throughout, combined basal area and areola constricted before and subangulate behind middle, costulae obsoletely indicated, basal areas partly shining and punctate, otherwise the propodeum is obscurely rugulose and opaque; wings of normal size; radial cell very short; intercubiti slightly convergent above, second distinctly longer than first and almost entirely bullated; nervulus recurved posteriorly; nervellus broken near bottom; legs stout, hind coxae large, closely punctate, especially above. *Abdomen* very finely shagreened and subopaque; first segment broad, the postpetiole nearly square; all other tergites transverse; sheath about as long as first tergite, ovipositor strongly compressed, subsagittate at apex.

Ferruginous, with occiput, stains along thoracic sutures, and petiole black; clypeus and mandibles testaceous; flagellum blackish with a broad white annulus; anterior margin of pronotum and scutellum paler, the latter at apex and postscutellum yellowish; wings hyaline, veins blackish, stigma and costa as well as tegulae stramineous; front and middle coxae and all trochanters stramineous; hind femur more or less piceous within.

Male.—Head more narrowed below, the face, clypeus, and mouth narrower; flagellum tapering toward apex, basal joints longer; thorax more rounded, not so distinctly flattened above and below, more shining; propodeum completely areolated, more strongly rugose behind; abdomen narrower, petiole more slender, postpetiole longer than broad, second tergite as long as broad. Face, frontal orbits, clypeus, mouthparts, lower cheeks, scape below, humeral angle of pronotum, subalar tubercle, tegulae, and front and middle coxae and trochanters yellow. The male is very variable in color, the darkest specimens having the head, except below antennae, and the thorax, except dorsally, piceous to black.

Type locality.—Riverdale, Maryland.

Type.—No. 51057, U. S. National Museum.

Described from 15 females and 13 males, all taken May 18–21, 1934, by H. S. McConnell of the Maryland Agricultural Experiment Station on or near the ground where many hundreds of the larvae of *Tomostethus multicinctus* Rohwer were entering the soil for pupation. Presumably the species is parasitic on the *Tomostethus*.[3]

[3] Since this was written Mr. McConnell has reared the species from cocoons of *Tomostethus*.

Calliephialtes laspeyresiae (Uchida), n. comb.

Ephialtes laspeyresiae Uchida, Insecta Matsumurana, vol. 6: 160, Pl. and fig. 18, 1932.

Dr. Uchida has been kind enough to send me a female specimen (Paratype, No. 51058, U. S. National Museum) of this species. Also there are before me one female and three males reared from *Grapholitha molesta* (Busck) in Japan by G. J. Haeussler of the Bureau of Entomology and Plant Quarantine.

This species and *benefactor* Cushman, an American parasite of the same insect, are very similar, and were it not for the very distinct difference in the male genitalia I would be inclined to consider them as no more than races of the same species. The genital sheath in *benefactor* is unusually long, slender, and strongly exserted, while in *laspeyresiae* it is of normal form. Otherwise the two species structurally are practically identical.

The female of *laspeyresiae* differs from that of *benefactor* in the paler under side of the basal joints of flagellum, the almost entirely pale yellow front and middle coxae, and the possession of a whitish streak on the extensor surface of the hind tibia reaching from the base nearly to the apex.

The male differs from that of *benefactor* in having the under side of the flagellum pale yellowish stramineous except toward the apex, the front and middle legs almost entirely pale, the hind coxae and femora rather broadly pale at the apex, and the dorsal stripe of the hind tibia more conspicuous (sometimes lacking in *benefactor*)

In neither sex does there appear to be any tendency to exhibit red coloration on the thorax, even on the scutellum. However, specimens occur rarely in both sexes of *benefactor* with entirely black thorax

Lissonota recurvariae, n. sp.

In Cresson's key to the species of *Lampronota* (Trans. Amer. Ent. Soc. **3**: 160, 1870) the female runs to *laevigata* Cresson and the male to *pleuralis* Cresson, from both of which it differs in the white margins of the tergites and in other details.

Female.—Length 4.5 mm., antennae 4.5 mm., ovipositor 5.0 mm.

Head much narrowed behind, temples strongly receding but strongly convex, little more than half as long antero-posteriorly as short diameter of eye; ocellar triangle weakly transverse; ocell-ocular and postocellar lines equal and a little longer than diameter of an ocellus; vertex and temples minutely coriaceous, subpolished; face and frons subopaque, coriaceous; head in front view a little broader than long, eyes about as long as width of face, mostly parallel, but slightly divergent toward lower ends; face prominent medially; clypeus strongly convex and deeply separated from face; malar space nearly as long as basal width of mandible; antennae 30-jointed, very slender filiform with all flagellar joints much longer than thick. *Thorax* slender, rather strongly compressed, twice as long as deep, subopaque coriaceous and minutely punctate, pronotal scrobe and speculum polished; mesoscutum and scutellum distinctly longer than broad; propodeum opaque,

the sculpture very fine and dense with a suggestion of transverse aciculation, with a narrow median groove, transverse carina at apical fourth; legs slender, hind coxa reaching apex of first segment; areolet sessile, nervulus postfurcal, postnervulus broken far below middle, nervellus broken at lower third and inclivous. *Abdomen* slender, subopaque coriaceous, without punctation, the sculpture coarser in the impressions; first tergite fully a half longer than broad at apex; second and third tergites both longer than broad at base, second nearly as long as first; hypopygium hardly reaching apex; ovipositor very slender, sheath slightly longer than body.

Black with the following parts whitish: Apical half or more of clypeus, mouthparts, spots in superior orbits, more or less broken lines on anterolateral margin of mesoscutum, tegulae, narrow bands at apices of tergites 2–6, interrupted laterally on 4–6, and hypopygium and venter largely; legs ferruginous, front and middle coxae and trochanters more or less whitish, the front ones almost entirely so; hind trochanter piceous, apically and below whitish; hind tibia and tarsus fuscous; wings hyaline, venation brown, stigma paler.

Male.—Essentially like female, but eyes and ocelli larger, ocell-ocular line hardly as long as diameter of an ocellus; antennae 34-jointed; abdomen even more slender, first tergite nearly twice as long as broad at apex.

The following whitish, in addition to the parts so designated for the female: Face, inner orbits and clypeus throughout, cheeks, lower margins and humeral angles of pronotum, notauli, subalar tubercle, a stripe on lower mesepisternum, and apex of seventh tergite. The entire front and middle coxae and trochanters, the apical joint of the hind trochanter, and the apex of the hind coxa are also whitish.

Host.—*Recurvaria piceaella* Kearfott.

Type locality —Bristol, Maine.

Type.—No. 51059, U. S. National Museum.

One of each sex reared July 6 (female) and July 3 (male), 1932, under Gipsy Moth Laboratory Nos. 9590e47 and 9390e43.

An abnormal male from the same host at Boothbay, Maine, June 26, 1932, Gipsy Moth Laboratory No. 9590e30, is not included in the type series because of its abnormality.

Genus Neliopisthus Thomson

I have previously[4] discussed the characters, systematic position, and synonymy of this anomalous genus, and the three North American species known at that time. Since that publication I have added a fourth species, and present herewith two additional species, together with a key for distinguishing the six North American species.

KEY TO NORTH AMERICAN SPECIES

1. Face fully twice as long as broad and three-fourths as broad as frons; eyes not longer than width of frons . . . 2
   Face much less than twice as long as broad and not or barely two-thirds as broad as frons; eyes longer than width of frons . . . 5
2. Hind coxae black . . . 3
   Hind coxae red . . . 4

[4] Proc. U. S. Nat. Mus. 56: 379. 1919.

3. Middle coxae largely piceous; joints 11–12 of flagellum white on inner side; ovipositor sheath barely as long as first segment . . *niger* Cushman
   Middle coxae whitish, only extreme base piceous; flagellum entirely black; ovipositor sheath distinctly longer than first segment . . . . *longicauda*, new species
4. Malar space nearly half as long as basal width of mandible; intercubitella not or barely as long as abscissula; mesoscutum in female largely or entirely red . . . *luggeri* (Ashmead)
   Malar space very short; intercubitella distinctly longer than abscissula; mesoscutum in female entirely black *nigridorsum* Cushman
5. Ocelli large, in female much more than half as long as, in male longer than, ocell-ocular line; mesoscutum in both sexes largely red, if at all black this color medial *densatus* (Say)
   Ocelli small, in female not or little more than half as long as, in male distinctly shorter than, ocell-ocular line; mesoscutum in female largely black, with center of disk red, in male thorax not at all red . *piceae*, new species.

Neliopisthus longicauda n sp.

Very similar to *niger* Cushman, but distinguished at once by its distinctly longer ovipositor sheath, paler middle coxae, and lack of any trace of antennal annulus.

Female.—Length 6 5 mm.; antennae 4.5 mm.; ovipositor sheath 1.3 mm. *Head* more than twice as broad as thick, temples strongly convex; ocellar triangle strongly transverse; eyes slightly shorter than greatest width of frons, weakly convergent below; face more than twice as broad as long, medially almost hemispherically elevated; clypeus nearly as long as face; foveo-ocular line fully a third as long as interfoveal line; malar space nearly half as long as basal width of mandible; antennae 30-jointed, basal joint of flagellum about three times as long as thick. *Thorax* hardly twice as long as deep, densely punctate and with dense, short pubescence; areola nearly as broad as long, broadly truncate at base. *Abdomen* broadly ovate, distinctly broader than thorax; first tergite with a strong carina from spiracle to apex, postpetiole with a median longitudinal impression; second tergite much broader at apex than at base; ovipositor sheath distinctly longer than first segment.

Black; center of mesoscutum and scutellum (in type) dark rufous; spot at top of eye, face except medially above, clypeus, malar space, cheeks, mandibles, palpi, upper and lower margin of pronotum and tegulae whitish; wings hyaline; veins black, stigma reddish stramineous, legs ferruginous; front and middle coxae and trochanters whitish, the trochanters behind and middle coxae basally piceous; hind coxa and basal joint of trochanter black femur basally below, tibia basally and apically above, and tarsus infuscate; abdomen black with tergites except first very narrowly pale at apex; venter pale with sternites piceous; sheath black with ventral margin partly whitish.

Type locality.—Lind, Washington.

Type.—No. 51060, U. S. National Museum.

Two females taken May 15, 1922, and May 7, 1923, by M. C. Lane of the Bureau of Entomology and Plant Quarantine.

The paratype is smaller, lacks the red color on the thorax, and has the legs more extensively dark.

Neliopisthus piceae, n. sp.

Similar to *densatus* (Say), from which it is most easily distinguished by the distribution of red on the thorax.

Female.—Length 4.0 mm., antennae 3.5 mm., ovipositor sheath 0.8 mm. *Head* half as thick as broad, temples strongly convex; ocellar triangle not very strongly transverse; diameter of an ocellus about half as long as ocell-ocular line; eyes strongly convergent below, longer than width of frons; face nearly as long as its least width, medially somewhat elevated; clypeus much shorter than face; foveo-ocular line and malar space much reduced; antennae very slender filiform, first flagellar joint fully four times as long as thick. *Thorax* very nearly as long as deep, densely punctate; areola much longer than broad, narrowly truncate at base. *Abdomen* rather narrow, hardly broader than thorax; first tergite without carinae from spiracle to apex, postpetiole without median impression; second tergite nearly as long as first, its sides weakly divergent; ovipositor sheath distinctly longer than first tergite.

Black, center of mesoscutum, scutellum, mesopleurum, and metapleurum more or less rufous; spot at top of eye, face, clypeus, malar space, cheeks, mandibles, palpi, scape and pedicel below, upper and lower margins of pronotum, and tegulae whitish; legs ferruginous, front and middle coxae and trochanters whitish; basal joint of hind trochanter piceous at base, whitish at apex; tibia basally and apically above and tarsus infuscate; wings hyaline, veins blackish, stigma stramineous; abdomen black, tergites beyond first broadly ferruginous laterally and narrowly pale apically; venter whitish with sternites piceous; sheath black, its lower margin partly white.

Male.—Eyes parallel below antennae; foveo-ocular line and malar space each about half as long as basal width of mandible; diameter of an ocellus nearly as long as ocell-ocular line; areola fully twice as long as broad; abdomen distinctly narrower than thorax Black without ferruginous, at most the abdomen piceous laterally; hind coxae more or less piceous above.

Host.—*Recurvaria piceaella* Kearfott.

Type locality.—Southport, Maine.

Type.—No 51061, U S. National Museum.

Two series of specimens, the first (two females and one male), including the type and allotype, reared from the host under Gipsy Moth Laboratory Nos. 12467 and 9590 at Southport and Bristol, Maine; the second (three females and two males) received from Stanley Garthside, who collected them in Itasca State Park, Minnesota, in September 1927.

The Minnesota specimens are larger, with the red color and the pale margins of the tergites brighter. One of the females in the latter series is headless.

Oocenteter, n. gen

Head in dorsal view transverse, the temples nearly as broad as eyes and very strongly convex; in front view broadly transversely oval; eyes strongly convergent below; clypeus deeply separated, convex, broadly rounded at apex; malar space nearly obliterated; mandibles stout, strongly convex basally, lower tooth the longer; palpi very short and stout; ocelli in a strongly transverse triangle; occipital carina somewhat more sharply curved

medially than elsewhere, meeting hypostomal carina shortly behind base of mandible; antennae in female a little longer than head and thorax, stout and slightly tapering toward apex, in male somewhat longer and more slender, scape almost squarely truncate at apex. *Thorax* stout ovoid; epomia lacking; notauli weak; scutellum strongly convex, medially higher than mesoscutum, immargined laterally, fovea very deep, smooth; postscutellum with a deep, undivided fovea at base; sternauli weakly impressed anteriorly; mesolcus very deep, not closed behind; metapleurum nearly as high as long, strongly convex; propodeum very short, carinae very high, especially the apical carina, costulae lacking, basal area and areola nearly equal in size and triangular, spiracles circular and situated on a small elevation; wing veins heavy; stigma rather broad with radius at middle; radial cell short, barely as long on metacarpus as stigma; basal vein meeting medius at a slightly acute angle; areolet elongate, oblique with recurrent nearly at its apex; discocubitus strongly curved basally; recurrent nearly straight, the bullae not or weakly separated; nervulus postfurcal and strongly inclivous; postnervulus broken far below middle; nervellus strongly inclivous and broken far below middle; legs, especially front femur, rather stout; tibiae and tarsi conspicuously spinose; calcaria very short; claws simple. *Abdomen* broadly fusiform; first segment subtriangular, about as broad as long in female, a little narrowed in male, sides nearly straight, lateral carinae complete to apex, dorsal carinae to middle, basal lateral foveae very deep; hypopygium rather prominent though not reaching apex of abdomen; sheath short and rather broad, barely surpassing apex of abdomen, ovipositor very slender and slightly upcurved.

Type of genus.—*Oocenteter tomostethi*, new species

The natural position for this genus is somewhat obscure. The lack of epomia, the open mesolcus, and the entire lack of costulae would seem to exclude it from the Tryphonini, to which in general form and in the distinct dorsal carinae of the first tergite it seems most closely allied. Moreover, the structure of the ovipositor and the habit of internal parasitism definitely exclude it from that tribe. In the Mesoleptini most of its characters would place it in the subtribe Mesoleiina, where it runs best to *Hypsantyx*, though not with entire satisfaction To me it seems most closely related to *Trematopygus*, though it differs markedly from that genus in its deeply separated clypeus, convergent eyes, and very short ovipositor sheath. In most other respects it is similar to *Trematopygus*. Neither of these genera belongs, I believe, to the Perilissina, but rather to the Catoglyptina, where the gap between them and the more typical genera is partly bridged by *Provancherella* Dalla Toree. To this subtribe I would also relegate *Lethades* Davis and *Zaplethocornia* Schmiedeknecht.

The generic name refers to the habit of ovipositing in the egg of the host whereas the larva feeds within the host larva.

Oocenteter tomostethi, n. sp. Fig. 1

Female.—Length 5.5–7.0 mm.

Head densely, finely punctate, sparsest on temples and densest on face, with dense short silvery pubescence; temples nearly as long antero-posteri-

orly as short diameter of eye; diameter of an ocellus much shorter than ocell-ocular line and hardly half as long as postocellar line; convergence of eyes as 3 to 2; clypeus shining, sparsely and rather coarsely punctate, nearly twice as broad as long; antennae longer than head and thorax by the length of its apical 7 or 8 joints, 28- to 30-jointed, first joint of flagellum slightly more than twice as long as thick at apex and about a half longer than second joint, joints beyond middle transverse. *Thorax* conspicuously pubescent, especially laterally, shining, finely punctate, with speculum polished and impunctate, mesoscutum and scutellum subpolished and less densely punctate, and apical areas of propodeum irregularly roughened. *Abdomen* subopaque and densely, finely punctate, subpolished toward apex.

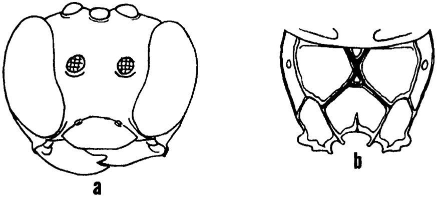


FIG. 1.—*Oocenteter tomostethi* Cushman. *a*, head, front view, *b*, propodeum

Head and thorax black; clypeus ferruginous, darker toward base; mandibles yellowish; palpi pale reddish; scape ferruginous, flagellum pale yellowish ferruginous; legs ferruginous, hind tibia slightly darkened above; wings hyaline, venation black with base of stigma and costa yellow, tegulae and a small humeral spot reddish. Abdomen ferruginous, more or less darkened at apex, especially laterally and ventrally, the last three ventral segments and sternites of others piceous, membrane yellow.

Male.—Eyes less strongly convergent; antennae longer and more slender, 33-jointed, none of the joints transverse; abdomen narrower, first segment somewhat blackened basally; otherwise essentially like female.

Host.—*Tomostethus multicinctus* Rohwer.

Type locality.—Riverdale, Maryland.

Type.—No. 51062, U. S. National Museum.

Described from the following material: Three females and four males (type and allotype) reared April 29, 1935, by H. S. McConnell of the Maryland Agricultural Experiment Station from cocoons of the host collected at the type locality; three females and five males extracted September 22, 1934, from cocoons of the host at College Park, Maryland, by Mr. McConnell; 29 females captured in the act of ovipositing in the eggs of the host on May 4, 1934, at Riverdale by Mr. McConnell; and two females reared from the same host at Boston, Mass., on May 14, 1925, under Gipsy Moth Laboratory No. 12164K17b.

Perilissus tomostethi, n. sp.

Female.—Length 7 mm., antennae 8 mm.

Body opaque, shagreened, with only speculum polished and face, mesoscutum, mesopleurum, and basal tergites obscurely punctate.

Head a little more than half as thick as broad, temples broad and strongly convex; eyes and ocelli small, ocell-ocular line nearly twice the diameter of an ocellus and malar space two-thirds basal width of mandible; eyes slightly divergent below, not emarginate; clypeus not separated from face, but there is a broad shallow transverse concavity involving lower part of face and base of clypeus; clypeus broadly truncate, its margin thick and bearing coarse setiferous punctures; lower tooth of mandible larger and longer than upper tooth; flagellum slender filiform, all joints longer than thick, first joint about three times as long as thick. Notauli faintly impressed; scutellum strongly convex, not at all margined; propodeum without defined basal or middle areas but with three sharply-defined apical areas, which are irregularly rugulose; stigma large, with radius slightly before middle; areolet large, oblique, recurrent beyond middle; nervulus postfurcal; nervellus inclivous, broken below middle; legs long and slender, hind inner calcarium hardly a third as long as basitarsus, claws weakly pectinate. First tergite subpetiolate, less than twice as long as broad at apex, glymmae large, translucent; all other tergites transverse.

Dull ferruginous with occiput, middle of face and frons, upper side of scape and base of flagellum, thoracic sutures, stains on mesothoracic lobes and on pleura and sternum, petiole, coxae more or less, and hind femur piceous to black; sides of face and frons, malar space, and scutellum yellow; mandibles, palpi, tegulae, and wing-bases stramineous, hind tibia infuscate, tarsi yellowish; wings hyaline, venation blackish.

Male.—Structurally much like female but more slender, head larger, eyes smaller, and propodeum with areola defined laterally.

Head yellow with only occiput and middle of vertex and frons black; scape and pedicel below yellow; thorax black, with humeral angle and lower margin of pronotum, mark on lateral margin of mesoscutum, scutellum, irregular stripe below on mesopleurum connected with one across prepectus, and subalar tubercle yellow; mesoscutum sometimes partly ferruginous; front and middle coxae and trochanters and hind coxa and trochanter below yellow, hind coxa and trochanter otherwise black; hind femur black only within; first tergite largely black.

Host.—*Tomostethus multicinctus* Rohwer.

Type locality.—Boston, Mass.

Type.—No. 51063, U. S. National Museum.

Two females and one male reared from the host May 28 to June 1, 1928, under Gipsy Moth Laboratory No. 12164K17b.

Genus PHAEDROCTONUS Foerster

As generic characters go in the Campoplegini, the lack of the areolet and the broad, nearly right-angled radial cell of this genus together with the somewhat different facies seem to be sufficient ground for separating it from *Nemeritis* Holmgren. I therefore, do not follow Viereck[5] in synonymizing *Phaedroctonus* with *Nemeritis*. Some, if not all, of the American species as-

[5] Can. Ent. 57: 201. 1925.

signed by Viereck to *Nemeritis* should be transferred to *Phaedroctonus*. The genus seems to be associated rather definitely with coniferous trees.

The three new species which are described below are congeneric with the species *Phaedroctonus transfugus* (Gravenhorst), *argyresthiae* Rohwer, *minutus* Ashmead, and **(Limneria) Phaedroctonus cupressi** (Ashmead), (new combination), and also, apparently, with the new species described by Viereck in the work cited.

Phaedroctonus epinotiae, n. sp.

In Viereck's key to North American species of *Nemeritis* (loc. cit., p. 178) this will run directly to *cupressi* (Ashmead) and agrees with all the key characters leading to that species. From the type of *cupressi* it is immediately distinguishable by its much more strongly receding temples, broader abdomen, and shorter ovipositor sheath.

Female.—Length 4.0 mm, antennae 3.0 mm, ovipositor sheath 0.8 mm.

Head granularly opaque, in dorsal view transversely ovate, occiput rather deeply concave, temples strongly receding and only moderately convex; diameter of an ocellus and postocellar and ocell-ocular lines subequal, the first sometimes slightly the shortest; eyes distinctly convergent below; face slightly broader above than length of combined face and clypeus; clypeus convex, rather strongly rounded at apex and separated from face by an arched impression; malar space distinctly more than half as long as basal width of mandible; antennae 25- to 27-jointed (26-jointed in holotype), barely three-fourths as long as body. *Thorax* much more than twice as long as broad, the propodeum sloping gently from near base and overlapping more than the basal third of hind coxa; thorax generally finely granularly opaque with only speculum polished, with distinct punctation, the propodeum minutely shagreened; basal area very narrow and nearly parallel-sided, areola much longer than broad, acutely angled at base, longitudinal carinae beyond basal and the costulae obsolescent or absent; wings and legs normal for the genus. *Abdomen* opaque granulate, very weakly compressed apically; second tergite as long as first and fully three times as long as broad at base, spiracles distinctly but not far beyond middle; third tergite as long as broad at base; sheath only slightly longer than first segment.

Black; mandibles, palpi, scape and pedicel beneath, and tegulae yellow; wings hyaline, venation blackish; front and middle coxae piceous at base, their apices and their trochanters yellow, their femora and tibiae pale ferruginous, the tibiae above and their tarsi stramineous, the tarsus fuscous apically; hind coxa black, basal joint of trochanters piceous, apical joint yellow, femur rufo-piceous, tibiae fuscous, slightly paler at base and in middle, calcaria white, tarsus fuscous; abdomen black, the compressed portion yellowish ferruginous below, plica yellow.

Male.—Essentially like female; antennae nearly as long as body; malar space barely half as long as basal width of mandible; front and middle coxae largely yellow.

Host.—*Epinotia nanana* Treitschke.

Type locality.—Bristol, Maine.

Type.—No. 51064, U. S. National Museum.

Seven females and 13 males reared from the type-host under Gipsy Moth Laboratory No. 9590, mostly from the type locality, two males from Harps-

well, Maine, and one male from Georgetown, Maine; also one of each sex labelled "ex leaf-miner on *Picea*" under Gipsy Moth Laboratory No. 12467, the female from Southport, Maine, and the male from the type locality.

Phaedroctonus temporalis, n. sp.

Like *epinotiae* this species runs best in Viereck's key to *cupressi* (Ashmead), but has the temples broader and the ovipositor longer. From the above description of *epinotiae* it differs principally as follows:

Female.—Length 5 mm., antennae 3.5 mm., ovipositor sheath 1.5 mm. *Head* in dorsal view transversely oblong, temples extending straight backward and continuous with outside tangent of eye, occiput less strongly concave; postocellar line distinctly longer than ocell-ocular line, the latter not or barely as long as diameter of ocellus; eyes virtually parallel; clypeus nearly flat, not separated from face, apex nearly transverse; malar space barely longer than basal width of mandible; antennae 28-jointed; longitudinal carinae of propodeum distinct, parallel; abdomen more distinctly compressed; ovipositor sheath more than one and a half times as long as first segment.

Front and middle coxae more extensively black, the middle coxa entirely so above and reddish brown below; basal joint of middle trochanter somewhat darkened basally; front and middle tarsi infuscate; compressed portion of abdomen not pale below.

Host.—*Laspeyresia youngana* Kearfott.

Type locality.—Groton, Vermont.

Type.—No. 51065, U. S. National Museum.

Two females reared August 15, 1927, under Gipsy Moth Laboratory No. 12164M255a, from infested cones of red spruce.

Phaedroctonus piceae, n. sp.

Runs in Viereck's key to *laevis* Viereck, but is apparently distinct from that species in its entirely black front coxae, darker tarsi, uniformly dark hind femur, and entirely black tergites.

Differs from above description of *epinotiae* as follows:

Female.—Length 4 mm., antennae 2.5 mm., ovipositor sheath 1 mm. *Head* in dorsal view with temples strongly convex and weakly receding, occiput less strongly concave; postocellar line evidently longer than ocell-ocular line or diameter of ocellus, the latter two subequal; eyes virtually parallel; clypeus weakly convex, not separated from face, weakly rounded at apex; antennae 23- to 24-jointed (24-jointed in holotype), less than three-fourths as long as body; thorax but little more than twice as long as broad, propodeum sloping convexly and abruptly and not reaching to basal third of hind coxae; areola hardly longer than broad, distinctly defined laterally, costulae distinct, petiolar area slightly concave and rugulose; second tergite distinctly shorter than first and distinctly less than three times as long as broad at base, third tergite distinctly broader at base than long; sheath about a half longer than first segment.

Scape and pedicel and all coxae entirely black; hind tibia alternately annulated with whitish and black, middle tibia whitish above, stramineous below; hind tarsus fuscous with base of basitarsus whitish; tergites entirely black.

Male.—Essentially like female; antennae longer, malar space slightly shorter, front and middle coxae pale apically.

Hosts.—*Recurvaria piceaella* Kearfott (type); *Epinotia nanana* Treitschke.
Type locality.—Georgetown, Maine.
Type.—No. 51066, U. S. National Museum.

Two females reared from the type host under Gipsy Moth Laboratory No. 9590 from North Andover, Mass. (type) and Georgetown, Maine; one female from *Epinotia nanana* at Ocean Point, Maine, under Gipsy Moth Laboratory No. 12467; and one male reared from the type-host at Harpswell, Maine, under Gipsy Moth Laboratory No. 9590; all during the last week of June.

Cremastus grapholithae, n sp.

Very distinct from all previously described North American species in its very long propodeal areola, the posterior margin of which is nearly or quite interstitial with the lateral portions of the apical carina

Female.—Length 7.5 mm., antennae 4.0 mm., ovipositor sheath 2.5 mm.

Head finely shagreened all over, a little more than twice as broad as thick, temples short, strongly receding and weakly convex; diameter of an ocellus nearly or quite as long as postocellar line and distinctly longer than ocell-ocular line, head in front view distinctly transversely oval; face impressed and minutely punctate on each side of middle, distinctly broader than combined length of face and clypeus; eyes as long as width of face, parallel or very weakly divergent below; clypeus somewhat more than half as long as interfoveal line, inflexed and very broadly rounded at apex; malar space hardly two-thirds as long as basal width of mandible; antennae 29- to 32-jointed. *Thorax* hardly twice as long as deep, finely shagreened, with mesoscutum, scutellum, mesopleurum and sternum shallowly punctate, propodeum medially and apically more or less transversely rugulose; speculum polished; notauli very weakly defined anteriorly; scutellum weakly convex; propodeum extending well beyond middle of hind coxae, areola more than twice as long as broad, its posterior margin nearly or quite interstitial with lateral portions of apical carina; stigma rather broad, with radius distinctly beyond middle, nearly as long as radial cell measured on metacarpus; postnervulus broken above middle; nervellus broken at or a little below middle; hind legs rather stout, tibia as deep apically as femur, inner calcarium about a third as long as basitarsus. *Abdomen* slender; first tergite entirely without lateral carinae, its lateral margins nearly meeting ventrally; second tergite a little more than four times as long as broad at base; compressed portion three times as long as deep, third tergite slightly less deep than fourth; second tergite obscurely longitudinally striate, others shagreened; sheath twice as long as first segment

Black, ferruginous, and yellow; head yellow with stemmaticum and occiput black, the space between and middle of frons black to brownish ferruginous; antennae black, scape and pedicel yellow in front, flagellum more or less reddish below, especially at apices of joints; thorax ferruginous with pronotum medially, prescutum (usually), lateral areas of scutellum and postscutellum, propodeum medially, metasternum, and sometimes mesosternum black; propleura, upper and lower margins of pronotum, humeral margins of mesoscutum and notauli, scutellum except apex, tegulae, subalar tubercle, and an oblique band on mesopleurum yellow; wings hyaline, venation brownish, marginal half of stigma and metacarpus pale; front and middle legs pale ferruginous, coxae and trochanters pale yellowish, tibiae with a pale stripe on extensor surface; hind coxa and trochanter yellowish, basal joint of trochanter more or less marked with piceous, femur

piceous with distinct stripes of yellow on dorsal, ventral, and inner surfaces, tibia infuscate at base and apex, yellowish in middle and with a distinct yellow stripe on extensor surface, tarsus fuscous, paler below and at bases of joints; abdomen black, apices of tergites narrowly but indefinitely reddish, lower half or third of compressed portion pale yellow, epipleura yellowish hyaline, venter yellow.

Male.—Eyes and ocelli large, malar space and ocell-ocular line much reduced, diameter of lateral ocellus as long as or longer than postocellar line and several times as long as ocell-ocular line; eyes much longer than width of face, the latter hardly broader than combined length of face and clypeus; second tergite five times as long as broad at base.

Head and thorax colored as in female, but frons not black medially and pronotum not at all ferruginous; abdomen not at all yellow but tergites 3–5 each with a broad apical band of ferruginous, broader laterally, tergites 6 and 7 broadly yellowish ferruginous laterally.

Host.—*Grapholitha molesta* (Busck).

Type locality.—Harriman, Tennessee.

Type.—No. 51067, U. S. National Museum.

Described from fifteen specimens of each sex selected from more than twice that number and reared from the type host at field stations of the Bureau of Entomology. Seven females and 12 males, including the type and allotype, are from the type locality; one female from Kingston, Tennessee; one female from Cornelia, Georgia, one female from Raleigh, North Carolina; four females and two males from Berlin, Maryland; and one of each sex from Moorestown, New Jersey.

In one of the Harriman specimens the thorax is black only in the scutellar region.

In the additional material are specimens from Fairfax, Virginia, and Clemson College, South Carolina. Another lot not included in the type series was reared from *Acrobasis caryae* Grote at Brownwood, Texas, under Quaintance Nos. 27894, 27896, 27906, 27926, and 27929; while a single specimen from the Agricultural and Mechanical College, Mississippi, was reared from *Laspeyresia caryana* (Fitch).

Cremastus chilonis, n. sp.

Reminiscent, in its very dense short thoracic vestiture and long narrow areola, of the genus *Pseuderipternus* Viereck.

Female.—Length 9 mm., antennae 6 mm., ovipositor sheath 3.5 mm.

Head rather thick, barely twice as broad as thick, temples strongly convex but narrow, occiput rather deeply concave; eyes divergent below; face slightly wider at top than length of eye, opaque coriaceous and more or less distinctly punctate; frons and temples coriaceous; clypeus more than half as long as broad, broadly arcuate at apex; malar space subequal to basal width of mandible. *Thorax* opaque and with very dense, short, silvery pubescence; notauli rather deeply and sharply impressed; scutellum rather flat but not distinctly margined; propodeum extending a little beyond middle of coxae, densely and rather coarsely punctate, apical areas transversely rugulose, carinae unusually high, areola much longer than petiolar area and strongly separated from it; stigma narrow with radius at middle;

radial cell narrow, much longer on metacarpus than stigma. *Abdomen* stout, strongly compressed only apically, coriaceous, postpetiole and second tergite partly longitudinally striate, others sparsely punctate; first tergite with its lateral margins approximate and nearly enclosing the sternite, petiole deeply grooved laterally; second tergite barely twice as long as broad at base, hardly as long as first.

Ferruginous with head more yellowish and with the following black or blackish markings: Occiput, middle of vertex and frons, lobes of mesoscutum largely, mesosternum, propodeum partly to entirely, stains along all thoracic sutures, tergites 1 and 2 except apices, other tergites in basal middle; antennae, palpi, tegulae, and tarsi black or blackish, as are also the base and apex of each tibia, the hind femur at apex, and the hind trochanter; wings hyaline, venation blackish, stigma dark stramineous.

Male.—Essentially like female but ocelli larger in diameter, this being nearly as long as ocell-ocular line; abdomen narrower, the second tergite about two and a half times as long as broad at base Black color more extensive.

Host.—*Chilo forbesellus* Fernald.

Type locality.—Douglas Lake, Cheboygan County, Michigan.

Type.—No. 51068, U. S. National Museum.

Three females and three males from the type locality and two males labeled merely Cheboygan Co , all reared from larvae of the host during July and August 1934 by Paul S. Welch of the University of Michigan.

Cremastus protractus, n. sp.

Because of the unusually long posterior extension of the propodeum and the very long, slender, and blade-like abdomen this might be considered to represent a new genus, but since those portions of the body are subject to a considerable degree of variation within the present genus it seems wisest to place it here, at least for the present.

Female.—Length 10 mm., antenna 3 5 mm., ovipositor sheath 3 5 mm *Head* thin, more than twice as broad as thick, temples very narrow, moderately convex, occiput shallowly concave; ocelli small, diameter much shorter than ocell-ocular line; head in front view subtriangular, slightly broader than long; eyes parallel, face much broader than length of eye, coriaceous, subopaque with scattered minute punctures; frons coriaceous, rugulose in the scrobes and with a weak median carina below; clypeal suture at about level of lower eye margin; clypeus nearly twice as broad as long, apex nearly straight; malar space fully as long as basal width of mandible, which is only a little longer than broad; width of mouth (i.e , distance between bases of mandibles) distinctly less than that of face. *Thorax* slender, compressed, coriaceously opaque and evenly punctate, with propodeal "neck" extending slightly beyond apex of hind coxa; notauli broadly impressed; scutellum nearly flat, subcarinately margined nearly to apex; propodeum basally coriaceous with scattered punctures, transversely rugulose behind basal carina and laterally, areola and petiolar area confluent; wings, because of the great length of body, appearing very short, stigma broad with radius at middle; radial cell very short, hardly longer on metacarpus than stigma; legs rather short, hind femur reaching only a little beyond apex of first segment. *Abdomen* fully three times as long as thorax, very slender, blade-like, compressed from base of third tergite, this portion many times as long as deep, tergites beyond sixth concealed; first tergite with its lateral margins parallel, not enclosing the sternite, petiole with a deep furrow on

each side nearly the entire length; second tergite distinctly longer than first, about six times as long as broad at base, weakly longitudinally striate, its spiracles slightly beyond middle; compressed portion shagreened, with sparse punctation, tergites 3–6 each deeply incised at apical middle.

Black; apex of clypeus and mandible yellowish red; wings hyaline, venation blackish, tegulae and radices yellow; legs ferruginous, hind coxae toward base, hind tibia above, and tarsi blackish; venter yellowish with dark sternites.

Host.—*Coleophora* sp. on *Aster eatoni.*

Type locality.—Pullman, Washington.

Type.—No. 51069, U. S. National Museum.

One specimen reared July 16, 1933, by J. F. Gates Clarke of the Washington State College of Agriculture.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

GEOLOGICAL SOCIETY

526TH MEETING

The 526th meeting was held in the Assembly Hall of the Cosmos Club, March 13, 1935, President SCHALLER presiding.

Informal communications.—G. W. STOSE and ANNA I. JONAS: *Limestones of Frederick Valley, Maryland.* The Frederick Valley of Maryland is a limestone valley east of the Blue Ridge-Catoctin Mountain uplift, and therefore in the Piedmont belt. The limestone is locally exposed from beneath the cover of Triassic rocks which have been dropped down about 3,000 feet by a normal fault along the east foot of Catoctin Mountain. A few fossils of Ordovician age were collected from the limestone by Keyes as early as 1890. Fossils collected later from the Le Gore quarry were first regarded as Beekmantown but are now assigned to the Upper Ozarkian by Ulrich and Foerste. Bassler in 1919 separated the limestones of the Frederick Valley into two formations. He called the pure thick-bedded quarry rock Beekmantown limestone on the basis of the fossils found at the Le Gore quarry, and the thin-bedded slabby somewhat fossiliferous limestone Frederick limestone, and determined its age to be probably Chazy. He considered the Frederick to lie unconformably on the Beekmantown. Later Miss Jonas in re-mapping the limestones during a survey of Frederick County for the Maryland Survey found highly quartzose limestone everywhere present in the supposed Beekmantown at the contact with the Frederick, which threw doubt on the unconformable relations Recent structural study by Miss Jonas and Mr. Stose established the fact that the thick-bedded quarry rock is in synclines in the Frederick limestones and not in anticlines, as interpreted by Bassler. This structural interpretation conflicts with the fossil evidence as applied by Bassler. It was found that the confusion arose from correlating the pure quarry rock throughout the valley, which is generally unfossiliferous, with the quarry rock containing the Ozarkian (formerly Beekmantown) fossils in the Le Gore quarry. These fossils occur only in the north wall of the quarry and a vertical normal east-west fault passing through the quarry separates it from other pure limestone in the south wall of the quarry, which carries a fauna very similar to that in the underlying Frederick limestone. It was found that the Ozarkian is restricted to the small triangular area at

the north edge of the limestone valley, and the main body of pure limestone in the center of the Frederick Valley is probably of Chazy or later age and conformably overlies the Frederick limestone. The limestone of Ozarkian age is named Le Gore limestone, and the main quarry rock overlying the Frederick is named Grove limestone.

The Frederick limestone is correlated with the lower part of the Conestoga limestone, Pennsylvania, on the basis of its fossils, chiefly *Strophomena stosei*. The Conestoga limestone occupies a wider area than the Frederick. Well exposed outcrops of the unconformity at its base occur near Lancaster where it overlies Lower Cambrian limestone. Elsewhere it is unconformable on rocks ranging from Beekmantown limestone to Harpers phyllite. Frederick limestone on the east side of Frederick Valley unconformably overlies Antietam quartzite in which are found trilobite fragments. East of the Le Gore quarry Frederick limestone overlies Le Gore (Ozarkian) limestone and the steeply dipping intervening rocks are covered by the Frederick which was deposited on their upturned and eroded surface. West of the Valley, the Frederick limestone similarly overlies Antietam quartzite and Harpers phyllite in the down-dropped block between the Triassic rocks and Catoctin Mountain. Discussed by Messrs. GILLULY, MERTIE, RESSER.

J. S. WILLIAMS exhibited a piece of the living chamber of a large Pennsylvanian nautiloid cephalopod from Texas. The specimen came from the upper part of the Graham Formation near Graham, Texas. It is thought to represent a part of a coiled cephalopod larger than any previously known from rocks of this age in the United States. The specimen is not complete enough even for generic determination. Discussed by Messrs. SCHALLER, FOERSTE.

Program.—C. E. RESSER: *The Beltian system.* Discussed by Messrs. GILLULY, MERTIE, Miss JONAS

CHARLES MILTON: *Metamorphism of a granitic dike at Franklin, New Jersey.* A few hundred feet to the south of the zinc ore-body at Franklin, N. J., is an exposure, some hundred feet square, of a rock which has been variously interpreted as sandstone, trap, quartzite, and conglomerate. Evidence is presented that it is a metamorphosed quartz-microcline dike, of which numerous unaltered examples exist in the vicinity Albite depositing solutions have formed a fine-grained albite-quartz aggregate, in place of the granitic quartz microcline rock. Chemical and microscopic characters of the different rock types constituting the occurrence are discussed. The metamorphism, it is suggested, may be due to solutions emanating from the nearby minette which from observed geological relations intersects the granitic dike underground. (*Author's abstract.*) Discussed by Mr. A. C. SPENCER.

D. F. HEWETT: *Manganese oxides and the circulation of ground water.* During recent years, with the increase in the study of ground water problems, it has become widely thought that, unless water is confined in an aquifer, it moves very slowly below the level of ground water, and that particles of water move in a rather direct path from the point of intake to that of outlet. This is in contrast to an earlier belief that particles of water move in highly circuitous routes from intake to outlet.

The common hydrous and anhydrous oxides of manganese, wad, psilomelane, manganite and pyrolusite are deposited where solutions carrying manganese in low states of oxidation encounter free oxygen, generally derived from the surface. In many parts of the United States in recent years, the common manganese oxides have been found below present levels of

ground water. If, in these regions, there is good evidence that the water levels have not changed greatly, the possibility is raised that oxygen-bearing surface water has circulated below the water table.

Recent explorations on manganese deposits in Virginia have revealed these oxides of manganese, not only 100 to 200 feet below the local water level but 50 to 100 feet below the nearby major streams. A good example is the Niesswaner shaft of the Kendall and Flick mine near Elkton in the Shenandoah Valley, but the best is a recent shaft at the Leets mine, 7 miles east of Lynchburg, Campbell County, which lies in the Piedmont region. The shaft is located on a hillside 300 feet west of a fork of Beaver Creek and 100 feet higher and was sunk to 300 feet or 200 feet below the stream. Water first stood 80 feet below the collar of the shaft, and a heavy flow of water was pumped all of the way to the bottom. Several hundred tons of high-grade manganese oxides were mined from a 50-foot winze below the 200 level in addition to several thousand tons mined years ago above that level. In December, 1934, there were 150 feet of drifts on the 300 level and nodules of psilomelane were abundant in four vertical zones of soft clays and sands formed by the decomposition of the enclosing shaly sandstone. These rocks are now interpreted as part of the Wissakickon schist which, with the nearby Cockeysville marble, is regarded as Pre-Cambrian. They strike northeast and dip nearly vertically.

So far as the writer is aware, no one has proposed that the Piedmont region nearby has been raised above its present elevation, and there is much physiographic evidence against the idea. James River, 2 miles northwest, flows on hard rocks, and low water level is about 50 feet above the 300 level of the mine. It seems, therefore, that surface waters have circulated freely and deposited manganese oxides at least 220 feet below the local water level, 200 feet below a nearby stream and 50 feet below a master stream 2 miles distant. These relations indicate that the surface water circulates freely at least 200 feet below local ground water level. (*Author's abstract.*) Discussed by Messrs. JOHNSTON, WELLS, LASKY, TRASK, SCHALLER, GILLULY, KRAMER, LEGGETTE, MEINZER, SPENCER.

527TH MEETING

The 527th meeting was held in the Assembly Hall of the Cosmos Club, March 27, 1935, President SCHALLER presiding.

Informal communications.—ANNA I. JONAS reported the finding of fossil fish bones, scales and plant remains in the Triassic rocks of the Potomac area in Fauquier County, Virginia. The locality is at Antioch, on the old Warrenton quadrangle, 3 miles north of Thorofare Gap on a county road which leads west through Bull Run Mountain to The Plains and only one-half mile east of the western border fault of the Triassic rocks. The fossils occur in westward-dipping black carbonaceous shales in the upper member of the Triassic sediments, the Gettysburg shale locally called Bull Run shale They are in large part soft red shales and red sandstone with thin beds of olive or black shales. Fossil wood, plant remains, and fish scales have been found in the lower member of the Triassic in the other areas of Virginia, largely in the Richmond and Farmville basins. The Potomac area previously has yielded only plant remains from near Manassas where they occur in the lower sandstone member. The fossils collected at Antioch have not been determined. From what was seen at the locality it appeared to be a good collecting ground and may contain other forms than those mentioned. Also search in the

vicinity might reveal other fossil-bearing outcrops of the same or other horizons.

L. W. CURRIER reported the results of a statistical study of the subjects presented before the Society for the five-year period ending March 27, 1935. Of the 148 papers, 35 were devoted to areal, physiographic, and glacial studies, 32 to stratigraphy, sedimentation and paleontology, 24 structural, 18 to petrology, mineralogy, and metamorphism, 14 to geophysics, isostasy, seismology, 13 ore deposits, 2 nonmetallic deposits, and 10 unclassifiable.

Program.—M. M. KNECHTEL and H. E. ROTHROCK: *Evidence of recent crustal movement at the west end of the Ouachita Mountains, Oklahoma.* Three thick competent sandstone beds, separated by several hundred feet of shales of the Pennsylvanian Atoka formation (Pottsville), form a ridge about 70 feet high in the western part of the town of Atoka, at the western end of the Ouachita Mountains in southeastern Oklahoma. The ridge trends about N. 20° E., parallel to the strike of the steeply westward-dipping rocks and approximately parallel to the traces of the Choctaw thrust fault, located less than a mile to the east, and of several minor faults in the vicinity of Atoka.

Water mains and sewer pipes, installed since 1906 and buried in trenches along six parallel streets which cross the east side of the ridge at right angles to its trend have been broken repeatedly at points where they pass through the lowermost sandstone bed, which is about 55 feet thick. All of these points lie nearly in a straight line and extend a distance of 2,000 feet along the ridge. The tile sewer pipe near the corner of A Street and Montana Avenue had been subject to stoppage for several years before it was uncovered in June, 1933, when it was found to be broken with a horizontal offset at right angles to its longitudinal axis, the portion east of the break being offset N. 20° E. relative to the portion west of the break. The displacement was horizontal only and amounted to 4 inches.

It is believed that these phenomena are caused by movement along a fault because of (1) actual horizontal offsetting of the sewer pipe along A Street, (2) alinement of all points of pipe failure, (3) parallelism of the direction of movement and alinement of pipe failures with the traces of several faults in the neighborhood. The movement is believed to be slow and more or less continuous rather than intermittent because earthquake shocks have not been felt in the neighborhood and because ruptures in all the water mains and sewers affected do not happen simultaneously, but generally occur singly and at different times.

The distortion and cracking of the foundations of several buildings on the ridge and the necessity for frequent readjustment of door and window frames in these houses may be related to the same disturbance Buildings in other parts of the town are relatively free from such troubles, though the quality of their construction appears to be no better than that of the buildings on the ridge. The breaks in water mains could not have been caused by freezing because in this region frost penetrates only a few inches below the surface, whereas the mains are buried under several feet of soil. Hillside creep of the shale beds on the east side of the ridge cannot account for the direction of the movement, which is horizontal and parallel to the axis of the ridge, and the maximum grade of about 6°, on the shale slope is believed to be insufficient to cause motion in the shale and a slumping of the overlying steeply tilted thick competent sandstone bed along which the pipe failures have taken place.

The Texas-Oklahoma earthquake of April 11, 1934, which was felt at

Hugo, Okla., 35 miles southeast of Atoka, is regarded by E. H. Sellards as due to movements on old faults in the Balcones fault zone. These movements and the movement at Atoka may be indicative of widespread crustal instability at the present time in the Ouachita belt. (*Authors' abstract.*) Discussed by Messrs. STOSE, MILTON, FERGUSON.

D. A. ANDREWS: *Early stages of glacial Lake Souris, North Dakota.* Glacial Lake Souris, of late Wisconsin age, lying within the present drainage basin of Souris River in north-central North Dakota, was briefly described in 1895 by Warren Upham, who described in detail the features of glacial Lake Agassiz 200 miles to the east in the Red River Valley. Field work in 1934 disclosed shore lines of stages of Lake Souris about 600 feet higher than had been described by Upham. The altitude of the highest shore line is 2140 feet above sea level. It is present on the northeast side of the late Wisconsin Altamont moraine, which occupies the divide between Missouri River and Hudson Bay drainage. Upham recognized a shore line at an altitude of about 1600 feet and other shore lines are present between the altitudes of 1900 and 2140 feet.

The shore lines of Lake Souris at altitudes of 1900 to 2140 feet above sea level trend diagonally across Ward County from northwest to southeast and extend into McHenry and McLean counties. The 2140-foot level of the lake drained through a spillway system in the vicinity of Russo and through Turtle Lake Creek, into the Missouri River; this channel is marked in part by Strawberry and Turtle Lakes.

The highest of a group of well developed shore lines at altitudes of 1560 to 1620 feet above sea level in eastern Ward and southern McHenry counties was drained by a spillway located in Ts. 148 and 149 N., Rs. 72 and 77 W., which entered the James River in the vicinity of Fessenden. This drainage line was later captured by the Sheyenne River flowing into Lake Agassiz. Successively lower stages of the lake represented by the lower shore lines were drained through spillways located progressively farther north and east until the present course of the Sheyenne River was established.

The 2140-foot level of Lake Souris could not have been dammed between a uniformly retreating ice front and the high divide occupied by the Altamont moraine because the altitude of the moraine decreases southeastward to less than 2000 feet in east-central Burleigh County, less than 60 miles from the shore lines studied.

The speaker suggests the following tentative interpretation of the origin of Lake Souris: The late Wisconsin glacier advanced southwestward with an even front to the present position of the Altamont moraine on the northeastern edge of the Missouri plateau. As the volume of ice in the glacier began to decrease the Turtle Mountains, in northeastern Bottineau and northwestern Rolette countries, with an altitude of 2000 feet or more, served as an effective barrier to the waning glacier and created a stagnant body of ice southwest of them; however, around the southeast side of the mountains the glacier still had sufficient volume to keep the ice in contact with the terminal moraine in Sheridan County and dam the water derived from the rapidly melting stagnant ice in Ward, McHenry, and parts of adjacent counties. There probably was a relief of more than 400 feet between the surface of active ice on the northwest side of the Turtle Mountains and the floor of the pre-Wisconsin valley in the region of ice southwest of the mountains. A lobe of ice probably extended southeastward along the valley now occupied by Souris River to the vicinity of Drake; the direction of movement in this lobe was nearly normal to the regional direction of ice

movement. Two straight, symmetrical steep-sided ridges, 15 to 25 feet high trending about N. 36° W., which are more or less continuous for about 10 miles in the vicinity of Drake and Balfour have been interpreted as beaches by Upham and as eskers by Campbell; they probably are alined features resulting from ice movement and indicating the direction of movement but they may have been modified by later wave action of Lake Souris. The northwest trend of other surface features in the vicinity of Drake and Balfour also suggests that a lobe of ice in the pre-glacial valley moved in a direction approximately at right angles to the direction of regional ice movement. (*Author's abstract.*) Discussed by Messrs. ALDEN, HESS, MATTHES, LEGGETTE.

A. A. BAKER: *Geologic structure of southeastern Utah.* Southeastern Utah, lying within the Colorado Plateau, is characterized by several types of structural features, including huge asymmetrical upwarps, domes associated with laccolithic intrusions, the southern edge of the Uinta Basin structural depression, a north-trending zone of normal faults at the west edge of the Plateau, and a group of numerous folds, faults, and faulted folds that are found in a limited area near Moab. Folding has occurred in the region several times since the end of the Mississippian, but the principal deformation that is reflected in the structure of the surface rocks took place at the end of the Cretaceous or early in the Tertiary and was therefore related to the Laramie orogeny. The large domical uplifts have a northerly trend and are strongly asymmetric with the steep limb toward the east; they were formed at the end of the Cretaceous, possibly as a reflection in the surface rocks of more or less vertical uplifting along deep-seated reverse faults The group of numerous smaller folds, faults, and faulted anticlines in the part of the region near Moab also is believed to have been formed near the end of the Cretaceous; their formation is obviously related to the presence of the plastic saliferous beds of the Pennsylvanian Paradox formation beneath the surface rocks, because the structural features of this type near Moab are typically developed only within the area underlain by the Paradox formation and because the saliferous beds have been intruded into the overlying rocks at the crests of some of the folds. Events in the Tertiary structural history of the region include the intrusion of igneous rocks in four isolated mountain groups, the downwarping of the Uinta Basin, and the development of the zone of normal faults at the west edge of the Plateau; it is not possible to determine the order of these events nor to determine whether they represent different modes of expression of one period of crustal disturbance. (*Author's abstract.*) Discussed by Messrs. HESS and SCHALLER.

528TH MEETING

The 528th meeting was held in the Assembly Hall of the Cosmos Club, April 10, 1935, President SCHALLER presiding.

Program.—C. F. PARK, JR., and R. A. WILSON: *The Battle Branch gold mine, Auraria, Georgia.* The Battle Branch gold mine is in the southwestern part of Lumpkin County, Georgia, about 60 miles north of Atlanta. Gold was discovered here in 1831, and the property has been worked at irregular intervals since that time. The mine was reopened in January, 1934, and has since produced about $20,000.

The ore deposit is of the lode type and consists of many stringers and lenses in the Carolina gneiss, generally parallel to the planes of schistosity, which trend about N. 30° E. The Carolina gneiss is a finegrained quartz-

muscovite-biotite schist, which locally contains considerable discoidal garnet. The foliation planes of the gneiss strike a few degrees east of north and dip 20°–45° E. Two other systems of fractures are present. One strikes approximately parallel to the lode and dips 50°–70° NW; the other strikes northwest and dips steeply either northeast or southwest.

The mine is opened by a shaft sunk 185 feet on the incline, or about 110 feet vertically below the bottom of an old hydraulic pit. Two levels have been driven from the shaft, at 85 and 185 feet on the incline. The saprolite and weathered rocks extend to about the 85-foot level; below this the rock appears fresh and unaltered. Three zones or bands of quartz are recognized in the underground workings. These zones range in width from a few inches to a few feet; they are generally separated by 3 to 10 feet of gneiss. In a few places two of the bands merge and form pockets of quartz of considerable size.

The gold is coarse; the largest nugget reported weighed about 14 pennyweight. The gold occurs in pockets and shoots of varying dimensions. The width on the strike is usually less than 10 feet, and the thickness is less than 2 or 3 feet. The length is the most variable dimension and ranges from about 10 feet to more than 100 feet. The largest pocket reported yielded about 9,000 pennyweights.

The foliation planes in the schist form gentle sweeping curves, both on the strike and on the dip. Narrow quartzite bands are present locally in the schist, and these bands tend to become thicker near the crests of the rolls. The northwestward-striking fractures are also better developed near the crests of the rolls. The ores are localized where the northwesterly striking fractures intersect the lode, and an especially favorable place to look for ore is where these intersections cut the northwestward-dipping fractures. The ore shoots are commonly limited by bands of coarse red garnet. A little post-ore movement is shown by smeared gold and sulphides and brecciation of the quartz. This movement was small, and offsets of more than about 3 feet have not been seen. No evidence of post-ore movement was seen on the lode.

The gangue minerals include quartz, garnet, kyanite, muscovite, biotite, chromium mica, chlorite, chlor-apatite, and small amounts of tourmaline. Three types of garnet are distinguished—(1) discoidal almandite garnet in the gneiss, (2) red almandite garnet bordering the ore shoots, and (3) a black garnet, mostly almandite, with a little spessartite, found in the gneiss immediately next to the quartz but rarely in the quartz. Both the almandite in the lode and the black garnet are coarsely crystalline. Kyanite is present in several places, and one gold shoot changed in depth to a tube of kyanite less than 2 feet in diameter.

The ore minerals include both yellow and red gold, galena, pyrrhotite, chalcopyrite, fine-grained pyrite, magnetite, and ilmenite. The red color of the gold is caused by thin layers of red iron oxide Small amounts of marcasite occur in seams. This mineral is probably of supergene origin. Pyromorphite is a common constituent in the saprolite ores. The silicate minerals, especially garnet, kyanite, and the micas, are coarse in and near the lode. They become progressively finer away from the lode. The silicate and ore minerals are thought to have been deposited (or the silicates possibly recrystallized) by the same fluids which, during the stages of sulphide deposition, were at considerably reduced temperatures and pressures. Gold and galena generally occur together and are considered to be approximately contemporaneous. The ores are thought to be hypogene. (*Authors' abstract.*) Discussed by Messrs. MERTIE, FERGUSON, SCHALLER, NOLAN.

W. W. Rubey: *The force required to move particles on a stream bed.* Geologists are familiar with the venerable Leslie-Hopkins law of current impact, which is that the diameter of the largest particle a current can move is proportional to the square of the velocity. But hydraulic engineers have found this deductive law of little practical use because it refers strictly to velocities very near a stream bed and such "bed" velocities are difficult if not impossible to measure. Instead, many engineers prefer to use the alternative DuBuat-DuBoys law of current drag or critical tractive force, which states that the diameter of largest particles moved varies as the product, stream depth by stream slope. This law, like its rival, rests on a deductive basis and it even has age priority but, above all, it has been found useful in estimating the sizes of particles moved by actual streams.

Upon submitting these two "laws" to the test of G. K. Gilbert's laboratory observations on carefully sized sands and gravels, it becomes evident that neither fits the facts completely. When the mean velocities of current are low, high values of the product, depth times slope, are needed to start movement of some particular grain size; but at high velocities, movement of the same grains starts when the depth-slope product is much lower. Clearly, the data fit better to some sort of compromise between the two classical theories than to either of them taken singly.

In this paper, an attempt is made to set up a physical background for such a compromise theory by (a) accepting the Leslie-Hopkins law of the relation between maximum particle diameters and "bed" velocities for a given particle-shape and roughness of bed, (b) calculating this "bed" velocity from mean velocity, hydraulic mean depth, stream slope, and the coefficient of frictional resistance of water, and (c) estimating this coefficient of resistance from a ratio of channel roughness, analogous to the one used by Nikuradse and Prandtl for rough pipes. The resulting formula, which appears to fit experimental data satisfactorily, indicates that, for a given degree of channel roughness, the diameter of largest particles moved is proportional to the product, mean velocity X (hydraulic mean depth X slope)$^{1/2}$.

Properly and sufficiently qualified, this compromise theory seems to be applicable also to large-scale natural streams, and it therefore may be useful as a basis for estimating some of the flood characteristics of the streams that have laid down ancient sediments. The more important of these essential qualifications are: (1) The formula does not apply to the movement of clay, silt, and fine sand because the viscous drag of water flowing past such small particles far outweighs the effect of current impact. (2) The formula applies only to streams in turbulent flow and not to thin sheets in viscous or laminar flow. (3) For slopes steeper than about 5°, further refinements of the theory are required. (4) Stream "erratics" (abnormally large boulders or pebbles that occur in minor quantities in many stream deposits) probably have reached their sites of deposition by rafting, caving from cut banks, dumping from steep tributaries, slow creeping on the stream bed, etc.—processes entirely different from those by which the bulk of the material is moved; and the theory thus does not apply to the diameters of these coarse "erratics."

As examples of the possible uses of the compromise theory, estimates were offered of (a) the maximum size of pebbles moved freely by the present Mississippi River, (b) the relative size of the Mississippi when it built certain Pleistocene gravel terraces, and (c) the general nature of the streams that deposited the Wasatch conglomerate in western Wyoming. (*Author's ab-*

stract.) Discussed by Messrs. HESS, MERTIE, MATTHES, CALLAGHAN, LEGGETTE, CAPPS, CADY, SCHALLER.

F. E. MATTHES: *Origin and age of the eastern escarpment of the Sierra Nevada.*

529TH MEETING

The 529th meeting was held in the Assembly Hall of the Cosmos Club, April 24, 1935, President SCHALLER presiding.

Program.—R. A. DALY: *The strength of the earth.* The address dealt specifically with the distribution of strength in the earth at the present time. According to the speaker's preferred "model" of the earth, notable strength is confined to a true, crystalline crust, nowhere exceeding about 80 kilometers in thickness. The thick underlying silicate shell is thought to be elastico-viscous and to have vanishingly small strength. Objections to, and arguments for this theoretical picture of the earth's interior were discussed. The substance of the address is printed in this JOURNAL 25: 389-399. (*Author's abstract.*) Discussed by Messrs. KEITH, WRIGHT, ADAMS.

530TH MEETING

The 530th meeting was held in the Assembly Hall of the Cosmos Club, May 8, 1935, President SCHALLER presiding.

Informal communications.—C. P. ROSS discussed the occurrence of a group of rare mercury chlorides in the mercury lodes of the Terlingua district, Brewster County, Texas, and other regions. These were studied some years ago by Hillebrand and Schaller, who noted incidentally that tests show the pink altered rock associated with the ore contains calomel. Tests made by J. J. Fahey show that calomel or a similar mercury chloride is present in most specimens of altered rock and cinnabar ore not only from the localities where mercury chlorides had hitherto been recognized but from widely scattered lodes of different characteristics throughout the region. Although so finely disseminated that no hint of its presence is afforded by visual inspection the quantity in most specimens tested is sufficient to be of commercial significance. More accurate data will be available when chemical work now in progress is completed.

Specimens of cinnabar ore in the U. S. National Museum from Alaska, Arizona, Arkansas, California and Nevada were tested by Fahey and found to contain calomel or a related mercury mineral. As there is reason to think that kleinite, one of the group of chloride minerals crystallized at a temperature above 130°C. and as the mercury in certain minerals of the group is in the mercurous state, it appears that these chloride minerals are of hypogene origin. These facts indicate that calomel and related minerals in significant amounts are of much more widespread occurrence than has hitherto been supposed. Their presence can be detected only by suitable chemical tests. As calomel does not yield metallic mercury by simple heating in air it seems possible that some of the mercury present in this form in ore may escape recovery in commercial reduction plants.

F. E. MATTHES exhibited some unusual wind-faceted pebbles and discussed their mode of origin. Discussed by Messrs. MISER, BRADLEY, GOLDMAN, R. C. WELLS.

Program.—W. G. PIERCE: *Some significant features of the Mississippian-Pennsylvanian contact in the Tri-State district.* In the summer of 1934 the United States Geological Survey made an investigation of the southeastern Kansas coal field. While mapping the Cherokee shale, of Pennsylvanian age,

which contains the principal coal beds of the field, the speaker also obtained data on the stratigraphy of the lower part of the formation and its relation to the underlying Mississippian limestone.

Some of the earlier work on the lead and zinc deposits had predicated a karst topography on the Mississippian surface upon which the Cherokee shale was deposited. This idea, however, does not appear to be supported by the stratigraphy, structure, and sink holes observed in that part of Cherokee County, Kansas, northwest of Spring River. A structure map of the base of the Cherokee shale compiled from drill hole data supplemented by surface observations shows two directions of structural trends in that part of the Tri-State lead and zinc district lying in southeastern Kansas. One trend is N. 35° E. and the other N. 40° W. An outstanding feature is a continuation of the Miami trough, which enters Kansas at Treece and extends northeastward beyond Lawton. There are also indications of smaller depression trends on both sides of the Miami trough and parallel to it. The two most prominent northwest trending structures intersect the Miami trough at Treece and Lawton. There is also the suggestion of a northwest trending structure about 2 miles north of Baxter Springs. The question of whether the structure indicated by contours drawn on the base of the Cherokee shale is due to pre-Cherokee erosion and deformation, or is due to post-Cherokee deformation is considered from the viewpoint of stratigraphic and physical data, which may be summarized as follows: With one exception, the basal 30 feet of the Cherokee is a uniform series of beds throughout the area covered, consisting of about 15 feet of dark shale at the base, overlain by a thin coal bed and above this 15 to 20 feet of sandstone which, in northeastern Oklahoma, is called the Little Cabin sandstone member. At the one place this stratigraphic section did not prevail, the relationship that exists can reasonably be interpreted as one of nondeposition of the basal Cherokee beds upon an area of slight relief in the Mississippian surface.

Nine recent sink holes are known in the area and in several of them the walls of ancient or fossil sink holes can be seen. In the fossil sinks, the Cherokee shale has been deformed after it was deposited. The material which fills the fossil sinks was obviously deposited on horizontal surfaces rather than in depressions, for, so far as can be observed, the strata in the lower part of the fossil sinks are identical with the adjacent undisturbed Cherokee section. So far as observed, the basal Cherokee does not contain any conglomerate and the top of the Mississippian does not have a chert rubble. Cross sections compiled from logs of holes drilled at intervals of 400 feet show that across such depressions as the Miami trough the Cherokee shale has been deformed with and practically to the same degree as the contact between the Cherokee shale and the Mississippian limestone. The irregularities in the Pennsylvanian-Mississippian contact in that part of Cherokee County, Kansas, studied are therefore thought to be due principally to deformation and solution that took place in post-Cherokee time. This interpretation, however, is not extended to the Tri-State district as a whole but is applied only to that part lying in Kansas. (*Author's abstract.*) Discussed by Messrs. C. S. Ross, WILLIAMS, SEARS.

G. F. LOUGHLIN: *Relation of structure to surface features in the Pikes Peak quadrangle, Colorado.* A study of folds in the Pikes Peak folio, expressed by remnants of sedimentary rock, shows that the larger irregularities in the present floor of pre-Cambrian granite conform to anticlines and synclines. The folds, formed during the Laramie revolution, range in trend from southeast in the southwest part of the quadrangle to northeast in the southeast

part and north in the adjoining Colorado Springs quadrangle. They are concentrically arranged around a central dome that includes Pikes Peak and the Cripple Creek mining district. This dome, though elevated during the folding and later movements, may have existed to some degree since pre-Cambrian time, and may never have been so thickly covered by sedimentary rocks as the surrounding region. During folding the south-central part of the quadrangle was squeezed between forces from the southwest and southeast and became a rather complex, south-pitching syncline composed largely of easily eroded Mesozoic and Carboniferous rocks. The compressive force from the southeast was strong enough to produce at least one overthrust, and may also have produced tear faults along the east edge of the south-central syncline. North of the syncline the force from the southeast produced another overthrust that passes northward into a monoclinal flexure with westerly dip, which extends along the central part of the quadrangle east of Oil Creek. These structural features must be considered in any attempts to reconstruct erosion surfaces.

The first two stages of post-Laramie erosion are represented by the summit and shoulders of Pikes Peak and by the higher mountains in the Cripple Creek district. In view of the regional structure, these two stages may have removed sedimentary rock without eroding a very great amount of granite. The third stage exposed the granite floor almost as extensively as it appears today. Volcanic activity followed, covering the undulating granite floor in the western half of the quadrangle, and was accompanied by deposition of the Florissant lake beds and water-laid tuffs in a shallow syncline. The fourth stage involved partial removal of the volcanic rocks and continued erosion of the high granite slopes. It was accompanied by the deposition of gravels or "grits" on synclinal floors and shallow valleys. Eruption of the Cripple Creek volcano followed and its erosion took place in 2 general stages, controlled by outlying masses of resistant phonolite, again exposing the granite floor. Faulting then dislocated the granite floor, especially along the central monocline, and caused subsidence of the south-central synclinal block. Subsequent stages of erosion lowered the valley of Oil Creek in this synclinal block and developed broad pediments in the dominant volcanic area to the west of Oil Creek; but in the higher eastern part where resistant granite dominated, it was confined to canyon cutting mainly along fault zones. In spite of these many stages of erosion, the undulating character of the granite floor is preserved, though it has been repeatedly exposed. (*Author's abstract.*) Discussed by Messrs. BRADLEY, RUBEY, SHENON.

WALLACE LEE: *Channeling in the Cisco group, Young County, Texas.* Discussed by Messrs. HENBEST, KING.

W. D. JOHNSTON, JR., and G. TUNELL, *Secretaries*

SCIENTIFIC NOTES AND NEWS

Prepared by Science Service

NOTES

National Park Service.—Under the direction of Acting Chief Naturalist COOPER a premiere showing of talking motion pictures in geology was given in the Connecting Wing Auditorium, Constitution Avenue, on the evening of October 30. Titles of the films were Atmospheric Gradation, Work of Rivers, Underground Water, Mountain Building, Geological Work of Ice, and Volcanoes. These films illustrate scenes from the national parks and typify the new educational device for the teaching of science. They are designed for use in the C.C.C. camps and schools.

GEORGE M. WRIGHT, Chief of the Wildlife Division, attended the annual meeting of the American Ornithologists' Union in Toronto, October 21–24. Following this, he attended the 31st Annual Convention of the National Association of Audubon Societies in New York City Director CAMMERER, Assistant Director BRYANT, GEORGE F. BAGGLEY of the State Park Wildlife Division and BEN H. THOMPSON, Special Assistant to the Director, attended the Audubon Societies' meeting. Mr. WRIGHT gave a talk entitled *Bootstraps of wildlife conservation* at this meeting.

WILLIS KING of the Wildlife Division presented a paper before the members of the Biological Society of Washington on the evening of November 2 regarding ecological studies of reptiles and amphibians in the Great Smoky Mountains National Park.

American Wildlife Conference.—A National meeting of all organizations interested in the conservation and restoration of game birds and animals will be held in Washington, February 3 to 7, 1936, under the auspices of the recently organized American Wildlife Institute. A planning committee is now functioning, and preliminary arrangements are rapidly taking definite form. The following organizations are represented on this committee: Bureau of Biological Survey, National Park Service, Forest Service, Bureau of Fisheries, Soil Conservation Service, Office of Indian Affairs, American Association for the Advancement of Science, American Wildlife Institute, Izaak Walton League of America, American Ornithologists' Union, National Association of Audubon Societies, Society of American Foresters, American Forestry Association, National Grange, National Rifle Association, Science Service.

National Bureau of Standards.—WILLIAM D. APPEL, chief of the textile section, discussed the standardization of textile test methods with members of Committee D-13 on textiles of the American Society for Testing Materials at the meeting of the committee in New York on October 16, 17, and 18 and with members of the Research Committee, American Association of Textile Chemists and Colorists in Boston on November 1. He addressed the New York Section of the Association on October 25 on consumer standards for textiles.

The work on the chemistry of wool being carried out in the textile section of the National Bureau of Standards with the cooperation of the American Association of Textile Chemists and Colorists received additional support during the summer through the appointment of Dr. J. A. CROWDER and Mr. ARTHUR L. SMITH to assist Dr. MILTON HARRIS with the work. Messrs.

APPEL, CROWDER, SMITH, and HARRIS reported on the progress of the work at a meeting of the advisory committee in Philadelphia on October 24.

During the past summer WILLIAM F. MEGGERS, chief of the spectroscopy section of the National Bureau of Standards, attended the Fifth General Assembly of the International Astronomical Union in Paris, and visited various scientific laboratories to determine the present status of spectroscopic research in Europe. Doctor Meggers is President of Commission 14 of the Union, on Standard Wave Lengths and Solar Spectrum Tables.

Pan-American wilderness areas.—A recommendation to establish reserves of primeval areas in the different countries of the Americas from the Arctic to the Antarctic was made before the Washington meeting of the Pan-American Institute of Geography and History by Dr. JOHN C. MERRIAM, president of the Carnegie Institution of Washington. Agreeing with Dr. Merriam's proposal, the Institute passed a resolution to recommend the matter to governments of Pan-American countries for careful consideration. The areas, Dr. Merriam said, should be so chosen as to be scientifically useful to all the countries of America, and, in fact, to the entire world. They should be maintained, he urged, in precisely their natural condition. It would not matter if they should be somewhat hard to reach by travel. For when wilderness areas are used as very popular parks they may get considerable wear and tear. Moreover, artificial park changes, such as roads, firelines, or ditches, may alter original values of the region for scientific study. At least, time and money spent on making the reserved areas accessible should be matched by expenditure to secure knowledge of the areas.

Safer landings.— Safer airplane landings are expected to result from a new instrument, developed by the National Advisory Committee for Aeronautics here, which makes possible, for the first time, an accurate plotting of the "blind spots" in a pilot's line of vision. Blind spots are those regions where the body, engine or wings of an airplane obstruct the view so that the pilot must make his landings, in part, by instinctive "feel" of his plane rather than by actual sight. Blind spots, too, are the menace of military airplanes in wartime, for an enemy aviator can approach in a blind spot zone and attack almost before the victim plane realizes anyone is near.

The new apparatus, which charts blind spots is the invention of MELVIN N. GOUGH of the N. A. C. A. staff at Langley Field, Va It is called the visiometer. Placed in the cockpit of a plane at the spot where the pilot's head comes in actual flight, the device measures accurately the exact parts of the plane which obstruct vision. Plotting the data thus obtained on graph paper, scientists obtain a plane projection of the three-dimensional field of view. The result is analogous to the Mercator projection of the three-dimensional earth on a wall map.

U. S. National Museum.—Several notable collections in paleontology were made in the West during the past digging season, by Curator C. W. GILMORE. From the Big Horn Basin in Wyoming have come the bones of a *Coryphodon*, popularly known as an "elephant-bear," an animal of the early Tertiary. Early Cretaceous formations yielded a large number of saurian fossils, notably what appears to be a fairly complete skeleton of one of the "bird-footed" dinosaurs. A *Pteranodon* wing-bone has been sent to the Museum by TOM H. WELLS, of Austin, Texas. This genus has not previously been reported south of western Kansas.

The National Museum's collection of the Paleocene fauna from the Crazy Mountain region in Montana, obtained by the late Dr. JAMES W. GIDLEY, has been worked over by Dr. GEORGE GAYLORD SIMPSON of the American Museum of Natural History, completing examinations left unfinished by Dr. Gidley. Some sixty species have been identified.

Bureau of Fisheries.—An agreement for cooperative research has been worked out with the Musher Foundation, Inc., of New York City, to study methods of preventing rancidity in stored fatty fish. W. J. HART, a graduate student at the University of Maryland, has been employed by the Foundation as a research associate, to work in the Bureau's technological laboratories at College Park, Md.

A specimen of a nautiloid cephalopod, of Devonian age, was discovered recently, embedded in the black marble baseboard of a corridor in the Bureau's section of the Department of Commerce building. It was first noticed by E. W. BAILEY, assistant chief of the division of scientific inquiry. Identification was made by DRS. A. F. FOERSTE and PAUL BARTSCH of the National Museum.

Biological Survey.—Resignation of J N. DARLING, chief of the Bureau since March, 1934, took place on November 15.

Decisions in several Federal courts recently have been unanimous in sustaining Federal regulations governing the shooting of migratory game birds, against legal attacks made on their validity These decisions were handed down in courts at Savannah, Ga , Lexington, Ky., and Springfield, Ill.

ARTHUR C. ELMER was appointed chief of the migratory waterfowl division on September 3.

The recent retirement of EDWARD A PREBLE, after forty-three years of service with the Survey, was marked by a testimonial meeting of members and retired members, where Mr. Preble was presented with a testimonial brochure and a gift consisting of the complete works of Thoreau, Burroughs and Muir.

VERNON BAILEY, former chief field naturalist of the Survey, retired in 1934, has been appointed as a collaborator to assist in certain field surveys where his exceptional knowledge of wildlife, and of its food and cover requirements, are especially helpful.

A dense stand of giant cut-grass (*Zizaniopsis miliacea*) was discovered at Dogue Creek on the Potomac, just south of Mount Vernon, during the past summer, by F. M. UHLER. Since this plant is a serious menace to duck feeding grounds, the stand was immediately destroyed. Removal of a long-established pest, the water caltrop, is progressing satisfactorily, with the assistance of a corps of C.C C. workers.

U. S. Geological Survey.— Dr. T. W. STANTON, Chief Geologist of the U. S. Geological Survey, has retired after continuous service on the Survey since 1889. For thirty years, Dr. Stanton had charge of the Survey's Section of Paleontology and Stratigraphy. Although well past the ordinary retiring age, Dr. Stanton had been continued at his post through special Presidential exemption. He was retired at his own request, and is succeeded by Dr. G. F. LOUGHLIN.

D. F. HEWETT has been appointed Geologist in Charge, Section of Metalliferous Deposits, to succeed G. F. LOUGHLIN, who is now Chief

Geologist. Mr. Hewett is the Survey's specialist on manganese and has given much attention to the discovery and development of deposits of this important mineral in this country. He has recently made special studies of the Warm Springs district in Georgia and of the mineral resources of the Boulder Dam region.

The practically clear Colorado River water which had been coming down from Boulder Reservoir during July and August 1935, suddenly became turbid September 3, and from September 3 to 14 carried about 2,000,000 tons of silt past the Willow Beach gaging station 10 miles below Boulder Dam. The regular examinations being made by the Geological Survey of the suspended and dissolved material in the river water at the Grand Canyon and Willow Beach gaging stations show that the water carrying this silt had flowed through and under the 4,500,000 acre feet of water in the reservoir without enough mixing or detention to permit deposition of the silt in the reservoir.

Suggestions to authors of papers submitted for publication by the United States Geological Survey, with directions to typists is the title of Editor B. H. LANE's revised and enlarged fourth edition of G. M. Wood's pamphlet published in 1916. Because of the clarity and proved worth of its general suggestions, this publication, although intended particularly for Geological Survey contributors, should also be found useful to writers in other fields.

Bulletin 862 on *The southern Alaska Range* by S. R. CAPPS, was published recently. The report describes an area of more than 23,000 square miles, largely unexplored until 1926 Although many patches within this great mountain area remain unsurveyed, its principal topographic and geologic features are now known This part of the range reaches heights of 10,000 to 12,000 feet and includes a labyrinth of ragged crests that nourish large valley glaciers, interspersed with timbered valleys whose beauty is further enhanced by the presence of magnificent glacial lakes. Here moose, caribou, bighorn sheep, and grizzly bears live in a primitive wilderness almost undisturbed by man. One of the highest peaks of the region is Mount Spurr, a volcano that still shows signs of mild activity; and other volcanoes lie to the eastward. They are the northern members of the long line of volcanic vents that stretches through the Alaska Peninsula and the Aleutian Islands. The geologic history of the region has been complex, the rock formations ranging in age from ancient gneiss, schist, and crystalline limestone to the present stream, lake, and beach deposits Intrusive masses of granitic rocks, both large and small, cut the southern Alaska Range, and it is likely that careful prospecting near the contacts of sediments with these intrusives will result in the discovery of lode deposits of gold, silver, copper, lead, and zinc.

Flathead Tribal Constitution.—The signing of the first of the projected Indian tribal constitutions, in the office of Secretary of the Interior ICKES, is regarded as a historic step in the relations between the Federal Government and the tribes. The first document of the kind to be ratified was the Constitution of the Flathead Indians. Prepared mainly by the tribe itself and accepted by popular vote five to one, it gives the Flathead Indians the legal machinery for organizing their own group and taking over a large measure of power over their own affairs. All Indian tribes who accept the provisions of the Indian Reorganization Act, passed by the last Congress, may work out their own constitutions, and a number of tribes have been actively engaged in this task.

The historic document was accepted by MARTIN CHARLO, 75-year-old Flathead chief, who replied in his native tongue to Secretary ICKES' words of welcome As on other historic occasions between Indian chiefs and white men, an interpreter echoed each speech in the alternative tongue Once adopted, a tribal corporation cannot be abolished by any Indian Commissioner or Secretary of Interior Only by Act of Congress can such an organization of Indians be dissolved

NEWS BRIEFS

Although approximately 540 miles away from the shock center of the November 1 earthquake in Canada, the tremors at Washington were sufficiently strong to affect scientific instruments not designed primarily for recording quakes At the U S Coast and Geodetic Survey's magnetic station at Cheltenham, Md , near here, a magnetograph for measuring and recording the variations in the horizontal component of the earth's magnetic field clearly detected the earth shivers between 1 07 and 1 19 A M , E S T

The Third World Power Conference, to be held at Washington simultaneously with the Second Congress of the International Commission on Large Dams, has been announced by the State Department, for September 7 to 12, 1936 President ROOSEVELT has accepted the honorary presidency of the Congress MORRIS L COOKE, Administrator, Rural Electrification Administration, is chairman of the executive committee

Forest fires have been much more numerous this fall than normal, but the total burned-over area has been very much less, the Forest Service announces This is ascribed in part to the presence of thousands of C C C workers in the forests, ready to go into action against fires before they assume major proportions

Direct radio-telephone service between the United States and the Dominican Republic was opened on October 31

The Association for the Study of Neoplastic Diseases held a dinner on September 6 in honor of Dr JOSEPH C BLOODGOOD, adjunct professor of surgery at the Johns Hopkins University School of Medicine and one of the founders and directors of the association, during its annual meeting in Washington, D C Dr JOHN SHELTON HORSLEY, Richmond, Va , presided, Dr CLARENCE C LITTLE, managing director of the American Society for the Control of Cancer, was among the speakers

The first lecture in the Smith Reed Russell Series for this year at the George Washington University School of Medicine was given before the student body, members of the faculty and invited guests on October 24 The guest speaker for the occasion was Surgeon General CHARLES R REYNOLDS, Medical Corps, U S Army The subject of his address was *The Medical Corps of the United States Army*

PERSONAL ITEMS

Dr CHI-TING KWEI, dean of Yale-in-China School of Science, Central China College, Wuchang, China, who is at present on sabbatical leave in the United States, is spending several months at the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, engaged in research work in terrestrial magnetism and electricity

Dr. HERBERT FRIEDMANN, curator of birds, U. S. National Museum, was elected to a vice-presidency in the American Ornithologists' Union at its fifty-third annual meeting in Toronto.

C. F. W. MUESEBECK, entomologist in the Bureau of Entomology, has succeeded Dr. HAROLD MORRISON as chief of the Division of Insect Identification.

Dr. I. T. HAIG, chief of the Division of Forest Management at the Northern Rocky Mountain Forest and Range Experiment Station at Missoula, Mont, has been appointed assistant chief of the Division of Silvics in Washington.

The appointment of ROBERT M. CHAPIN as chief of the Biochemic Division of the Bureau of Animal Industry has been announced by the U. S. Department of Agriculture. Since the death of Dr. MARION DORSET last July, Mr. Chapin has served as acting chief of this division.

Dr. WALTER H. LARRIMER, formerly with the Bureau of Entomology and Plant Quarantine, has joined the Forest Service as staff assistant in forest research.

Dr. JULIAN H. STEWARD, associate professor of anthropology at the University of Utah, was appointed on October 21 to the position of associate anthropologist in the Bureau of American Ethnology, Smithsonian Institution.

Dr. MAX VON LAUE, professor of theoretical physics at the University of Berlin, who has been lecturing at the Institute of Advanced Study at Princeton and at the Johns Hopkins University, gave a lecture on *Thermo-dynamic fluctuations* in the Library of the Department of Terrestrial Magnetism, on November 4, 1935.

Dr. MAURICE C. HALL, chief of the Zoological Division of the Bureau of Animal Industry, spoke before the Sigma Xi Club of Oregon State College on October 8 on *What is scientific research?*

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An * denotes the abstract of a paper before the Academy or an affiliated society

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

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